AN INQUIRY

INTO THE

PHYSIOLOGICAL AND MEDICINAL PROPERTIES

OF THE

VERATRUM VIRIDE:

TOGETHER WITH

SOME PHYSIOLOGICAL AND CHEMICAL OBSERVATIONS

UPON THE

ALKALOID VERATRIA

OBTAINED FROM THIS AND OTHER SPECIES.

BEING THE

PRIZE ESSAY TO WHICH THE AMERICAN MEDICAL ASSOCIATION AWARDED THE GOLD MEDAL FOR MDCCCLXIII.

BY

SAMUEL R. PERCY, M.D.,

PROFESSOR OF MATERIA MEDICA AND THERAPEUTICS IN THE NEW YORK MEDICAL COLLEGE.

Salus populi suprema lex.

REPRINTED FROM THE

TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION.

PHILADELPHIA:
COLLINS, PRINTER, 705 JAYNE STREET.
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"For the proper perfection of medicine as a natural science, two things are in main needed; the first is a right understanding of the causes and symptoms of disease; the second, a correct knowledge of the *action of medicines*. Should our acquaintance with these two subjects be complete, we should then be able to do all that man could by any possibility effect, in the alleviation of human suffering. This sublime problem is already being unravelled at one end. Diagnosis and Nosology are making rapid strides; and perhaps we shall soon know what we have to cure. But at the other end our medical system is in a less satisfactory condition; and though some impatient men have essayed, as it were, to cut the Gordian knot, and have declared boldly on subjects, of which they are ignorant, yet it must be confessed, that in the understanding of the action of medicines, and of their agency in the cure of diseases, we do not so much excel our ancestors. While other sciences are moving, and other inquiries progressing fast, this subject, so momentous in its applications, has, in spite of the earnest labors of a few talented investigators, made, after all, but little progress. *Let but those who feel this want bestir themselves to remove it*, and it will soon be done. Those doubts and difficulties, which are now slowly clearing away before the efforts of a few, will then be finally dispelled by the united energies of all; and instead of our present indecision and uncertainty on many points, we shall find ourselves eminently qualified to wage the conflict with disease, being skilled in that science whose name bespeaks its peculiar importance, the science of *Therapeutics*."

Headland, *Action of Medicines*.

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PHYSIOLOGICAL AND MEDICINAL PROPERTIES OF THE VERATRUM VIRIDE.

SECTION FIRST.

BOTANY AND PHYSICAL CHARACTERISTICS OF VERATRUM VIRIDE.

Nat. Ord.—*Melanthaceæ.*

Linn. Syst.—*Polygamia Monœcia.*

Common Names.—*American hellebore. Swamp hellebore. Indian poke. Itch weed, &c. &c.*

Part used in Medicine—*The root.*

The Veratrum Viride has a perennial, thick, fleshy root, "the upper portion of which is truncated, the lower solid, and beset with numerous whitish fibres or radicals." "The stem is annual, round, solid, striated, pubescent, and from three to six feet high; being throughout the greater part of its length closely invested with the sheathing bases of the leaves.

"The leaves are alternate, and gradually increase in size as they descend; the lower ones are from six to twelve inches long, oval, acuminate, pubescent, strongly ribbed, and plaited, the lower part of their edges meeting round the stem. The upper leaves are gradually narrower, the uppermost and the bracts, linear-lanceolate.

"The flowers are numerous, yellowish-green, and arranged in compound racemes, axillary from the upper leaves, and terminal. Each flower is accompanied by a boat-shaped acuminate, downy bract, much longer than its pedicle. Peduncles roundish, downy. The perianth is divided into six oval, acute, nerved segments, of which the alternate ones are the longest, and all contracted at the

base into a sort of claw, with a thickened cartilaginous edge. The stamens are six, with recurved filaments and roundish. Anthers two-lobed. Ovaries three, cohering with acute recurved styles as long as the stamens.

"The fruit consists of three capsules united together, and separating at top, and dehiscing on the inner side.

"Seeds flat, winged, imbricated."

It is indigenous in almost every part of the United States, growing in wet meadows and upon the banks of rivers.

"In this connection it may perhaps be asked, What are the botanical differences between Veratrum viride and Veratrum album?

"To this inquiry, I must answer, that all which I have ever been able to discover consists in the fact that the edges of the segments of the perigone, in Veratrum viride, are slightly incrassated, and contracted below their middle, which is not the fact in Veratrum album; and that the general aspect of Veratrum viride is coarser and rougher, and it is of a darker green color. These are small characters, but they appear to be permanent, incapable of change by climate, soil, culture, &c. &c."[1]

The root is the part used in medicine, and it should be gathered in the autumn after the top has died. It might probably be equally active in its medicinal effects if gathered very early in the spring, but this can seldom be done, for it commences to grow before the snow and frost have fairly disappeared.

When freshly gathered the root has a strong, pungent, acrimonious taste, and when bitten, leaves a prickling and bitter taste in the mouth; but it loses most of this acrimonious effect by drying. In order to preserve the root properly, it should be cut in fragments, well dried at a low temperature, and kept in a dry place, for if kept where it is damp it deteriorates very quickly.

The leaves possess but little of the active properties of the root.

History.—It was known and used by the Indian before the occupation of this country by the European. The best description of its early history, since that time, is given in Bigelow's *American Medical Botany*, though neither Bigelow nor Ware understood its therapeutic powers in acute diseases, but, like the ancient Asclæpiadæ, with their preparations of "white hellebore," used it only in chronic affections.

[1] Tully's Materia Medica, vol. i. p. 215.

About the year 1830, Drs. Tully and Ives, of New Haven, investigated very fully the therapeutic properties of the plant.

The attention of the medical profession was particularly called to its use in the treatment of acute diseases, by Dr. Charles Osgood, of Providence, R. I., in an essay written for the *American Journal of Medical Sciences*, 1835.

Dr. Osgood, in a very modest manner, gives his preceptor, Professor William Tully, the credit of first calling his attention to its proper therapeutic powers, but Dr. Osgood, like modest men in general, underrates his own merits, and has written a very truthful and praiseworthy essay, which has been studied by all who have followed in his footsteps, but has been excelled by none; it still stands unrivalled, the best monograph that has been written on the plant.

The writer of this "Inquiry" first learned the knowledge of the physiological and therapeutic properties of the plant from Dr. Osgood, in 1849, and he has constantly used it since that time.

By the majority of the profession, but little attention was paid to Dr. Osgood's essay, until the use of the plant was revived by Dr. Wm. C. Norwood, of Cokesbury, South Carolina.

Dr. Norwood published a pamphlet on the therapeutic properties of Veratrum viride in 1851, and disseminated it very widely; it has gone through three editions.

After this time the properties of the drug were discussed in many of the medical societies of this country, and many excellent articles have appeared from time to time, in the medical journals, especially in those of the South and West.

In 1856, the Section of Materia Medica of the New York Academy of Medicine, appointed the author of this work to prepare a monograph upon the plant, and open a discussion upon its properties in the Academy.

In the same year the Harveian Circle, of the city of New York, appointed Drs. Percy, Miller, and Belden to perform a similar duty for that Society.

In 1858, the Massachusetts Medical Society appointed Drs. Cutter, Richard, and Ingalls, a committee to bring this remedial agent to the direct attention of the Society, a task which they performed in May, 1858, and again in 1861. In the meantime many able papers appeared upon the uses of the plant, in the medical journals, among the best of which may be mentioned those of Professor M'Gugin, of the Iowa University.

SECTION SECOND.

CHEMISTRY AND PHARMACY OF VERATRUM VIRIDE.

DIVISION FIRST.

CHEMICAL HISTORY.

Dr. Charles Osgood, of Providence, R. I., published the results of some chemical experiments upon this plant in the *American Journal of Pharmacy*, vol. i., second series. He obtained a white, inodorous, and very acrid powder, which he thought to be the alkaloid principle of the plant, but no satisfactory experiments were made by him on the point.

In the 9th volume of the same journal, Thos. A. Mitchell gives a proximate analysis of the plant, and states that he obtained an active principle, in the form of a white powder, but he was unable to make any chemical examinations, as the amount obtained was very small.

In the 10th volume of the same journal, Henry W. Worthington gives a more complete analysis of the plant, and states that he obtained "an alkaloid substance identical with veratria," that it "was soluble in dilute acids," and that "the sulphate, tartrate, and oxalate were crystallizable salts."

To Mr. Worthington, then, is due the honor of having first announced by publication, and demonstrated by chemical tests that an alkaloid existed in the plant.

In the same journal for May, 1857, Mr. Joseph G. Richardson gives an elaborate chemical essay on this plant. After reviewing what was already known and giving the results of various experiments for obtaining the alkaloids, Mr. Richardson gives several tests for its detection, and also proves by many separate analyses that the alkaloid obtained by him was identical in its chemical reactions with the alkaloid obtained from Veratrum album.

In 1857 the author of this monograph presented for the inspection of the Fellows of the N. Y. Academy of Medicine, 38 grains

of the pure alkaloid obtained from Veratrum viride, and described the process by which it was obtained; this was in a very fine, white, amorphous powder, possessing all the physical properties of veratria. The Academy did not publish this analysis.

In 1862 Geo. J. Scattergood made an elaborate investigation of the alkaloid obtained from both species, the results of which he presented in an essay to the American Pharmaceutical Association, at their meeting, August, 1862, and it may be found entire in their printed proceedings of that year.

DIVISION SECOND.

PROCESS FOR OBTAINING THE TINCTURE, RESINOID, AND ALKALOID.

Tincture.—The root, coarsely powdered, is treated with alcohol fortius, sp. gr. 0.817, by percolation, the alcohol distilled off, and the residuum evaporated to an extract over a water bath until it is nearly dry, or until it ceases to become lighter upon being weighed at intervals of an hour or two.

To make the concentrated tincture spoken of in this work, one part of this extract is dissolved in ten parts of alcohol, 0.817, and filtrated.

Resinoid.—Veratrum viride root coarsely powdered is treated with alcohol, 0.817, by percolation, the alcohol distilled off, and the residuum evaporated to a soft extract. A saturated solution of this extract is made in alcohol, 0.817, and filtered slowly into a large quantity of cold water previously acidulated with sulphuric acid, and kept constantly stirred. The fluid is filtered off, leaving most of the resinoid substance in the beaker; fresh acidulated water is added, well stirred, and the whole then thrown on the filter, and repeatedly washed with cold water, until every trace of sulphuric acid is removed; it is then dried. This substance I have called resinoid. By repeated examinations, it is entirely free from every trace of alkaloid.

It is also free from the extractive substances that are soluble in water.

I have used this in the form of tincture, made by dissolving it in alcohol 0.817, of the strength of $\frac{1}{20}$ grain of the resinoid to each minim. This resin is of a soft consistence; about 25 per cent. of it is soluble in ether, and the remainder is harder and more friable.

Both resins produce the therapeutic action above noted, but the alcoholic resin is more uniform and certain in its action than the ethereal. The ether extracts the oily portions.

Alkaloid.—The processes adopted by Worthington, Richardson, and Scattergood may be found in the works already referred to.

The process that I have adopted for obtaining the alkaloid has differed from that recommended by either of these gentlemen.

Any quantity of the coarsely-powdered root of the Veratrum viride is moistened with water and packed into a percolator; water acidulated with hydrochloric acid is added, sufficient to cover the root, and allowed to stand for twenty-four hours.

It is then allowed to percolate, and the first portion of the fluid which contains most of the strength of the root, is kept by itself; fresh acidulated water is added, until the root is exhausted.

The latter liquid is evaporated to about one-quarter its former bulk, filtered, and the first portion of the percolate mixed with it; soda is then added so long as a precipitate forms.

The precipitate is washed in a small quantity of cold water and dried; it is then treated with ether, the ether is filtrated off, and allowed to evaporate.

This mass is then treated with water acidulated with hydrochloric acid, filtered, and ammonia added so long as a precipitate forms; the fluid is filtered off, the precipitate washed in a small quantity of cold water, and mixed with a small amount of animal charcoal, which has been previously moistened with a little alcohol.

The whole is put into a flask and alcohol added to it; the flask is put in hot water, and the hot alcoholic solution filtered off, and more alcohol added, which is treated in the same way.

The whole of the alcoholic solution is either distilled or evaporated, according to the quantity of alcohol used; and the soft mass that is left is treated with successive quantities of boiling water, acidulated with hydrochloric acid.

This solution is filtered and the alkaloid is precipitated with ammonia.

The precipitate when dry is treated with ether, filtered, and the ether allowed to evaporate slowly.

The alkaloid is in a semi-crystalline state and of a slightly yellow tinge.

To prevent the excessive and painful sneezing caused by inhal-

ing this alkaloid, I have found it advisable, when manipulating with it, to anoint the nostrils as far up as possible with castor oil, and to tie over the nostrils a piece of moistened sponge.

DIVISION THIRD.

CHEMICAL TESTS AND REAGENTS FOR THE DETECTION OF THE ALKALOID.

As I have obtained veratria from Veratrum viride, it is, if precipitated, a pure, white, amorphous powder; if from the evaporation of ether, it is semi-crystalline and of a slightly yellow tinge.

It is of an acrid and burning taste, but is not very bitter. It is necessary to be exceedingly cautious in handling it, for if a very minute portion is breathed up the nostrils, it excites violent sneezing, which is difficult to check, and occasionally produces alarming symptoms.

Its formula is probably the same as that of commercial veratria, $C_{34}H_{22}NO_6\overset{+}{V}e$.

If a small quantity of veratria be placed upon platina and held over a flame, it fuses at a gentle heat; if it be now removed it solidifies as it cools, and becomes a semi-transparent yellow mass; but, if the heat be continued, it swells up and is gradually dissipated. It is insoluble in water, but readily soluble in ether, alcohol, chloroform, and benzole.

It neutralizes acids, and forms salts which are soluble in water; they are of an acrid and persistently burning taste, and produce a considerable degree of irritation if rubbed upon the skin.

In the experiments I give below I have as closely as possible followed the experiments performed by my friend, Professor T. G. Wormley, upon the purified veratria (of Murk's manufacture) from Veratrum sabadilla, and published by him in the *Ohio Medical and Surgical Journal*, July, 1860.

My object was to institute a more elaborate research than that previously made by Mr. Richardson, and ascertain if the alkaloids from the different plants were identical in their chemical reactions.

For the purpose of experimenting, a given quantity of the alkaloid was dissolved in a given quantity of distilled water, with precisely sufficient hydrochloric acid to effect its solution.

1. *Potassa.*—Potassa produces in solution of hydrochlorate of veratria a copious, flocculent, dirty-white precipitate, which is not soluble in an excess of the reagent. If viewed immediately on precipitation by a low power of the microscope, it is seen in coagula, but if viewed after standing some minutes many short prismatic crystals will be seen amongst the coagula, which shortly disappear. The $\frac{1}{100}$ grain of this veratria is most readily detected by this reagent, and with the microscope $\frac{1}{1000}$ may be easily recognized. The carbonate of the alkalies acts in the same manner as potassa.

2. *Ammonia.*—The reaction is the same as with potassa, but the precipitate is slightly soluble in an excess.

3. *Nitric Acid.*—If concentrated nitric acid is brought into contact with this alkaloid it agglutinates into resinous-looking lumps of a dirty yellow color, which slowly dissolve in the acid. If the alkaloid is first moistened with water and a small quantity of nitric acid then applied, it exhibits a yellow tint, but on the addition of water forms a colorless solution.

4. *Sulphocyanide of Potassium.*—A flocculent white precipitate insoluble in excess of the reagent.

5. *Chromate of Potassa.*—A light yellow amorphous precipitate, insoluble in an excess.

6. *Bi-Chromate of Potassa.*—A copious, dirty yellow amorphous precipitate, insoluble in an excess of the reagent, but soluble in nitric acid.

7. *Ferrocyanide of Potassium.*—A copious bluish-black, flocculent precipitate, soluble if a small excess of the reagent is carefully added.[1]

8. *Ferricyanide of Potassium.*—An abundant greenish-yellow precipitate, soluble in an excess.

9. *Iodide of Potassium.*—A dirty white amorphous precipitate, becoming a dirty greenish-white upon standing some time.

10. *Iodine in Iodide of Potassium.*—A copious reddish-brown amorphous precipitate, soluble in liquor potassæ.

11. *Bromine in Bromo-hydric Acid.*—A dull yellow amorphous precipitate.

12. *Carbazotic Acid.*—A greenish amorphous precipitate, which upon standing a short time becomes a greenish-yellow.

[1] "This reaction takes place if an old solution is used, but if a new and pure solution is used there is no precipitate."—W.

13. *Bi-Chloride of Platinum.*—A dirty yellow amorphous precipitate.

14. *Bi-Chloride of Mercury.*—A white precipitate.

15. *Tannic Acid.*—A dirty white amorphous precipitate.

16. *Terchloride of Gold.*—A canary yellow amorphous precipitate, insoluble in an excess of the reagent, and insoluble in acetic acid, except upon the application of heat.

17. *Sulphuric Acid.*—This test should always be applied to the alkaloid or its salts in a dry state. If a small portion of the alkaloid is touched with a drop of strong sulphuric acid no color is immediately developed, but in the course of a minute a yellowish-red, and then a beautiful bright red color appears. This color will appear immediately upon touching the veratria with the sulphuric acid if the slide upon which it is placed is warmed. The color is not destroyed by heat, but it disappears after standing two or three hours; the color will disappear in fifteen minutes if a small crystal of bi-chromate of potash is stirred upon the mixture.

Professor Wormley has, by this reagent, detected $\frac{1}{5000}$ of a grain of purified commercial veratria.

This last reagent—sulphuric acid—is the only one of all these that can be deemed decisively confirmatory of the presence of veratria; the other reagents are common to so many organic substances that they can only be regarded as confirmatory in connection with the action of sulphuric acid.

There is but one substance with which it would be at all likely to be confounded by this reaction of sulphuric acid, and that substance is salicine. Sulphuric acid produces a red color on solanine, narceine, papaverine, and piperine, but, as with salicine, the color is produced immediately upon the contact of the cold acid.

But the reaction of sulphuric acid on salicine and veratria differ, for whereas on salicine the color is immediately produced upon the application of sulphuric acid on a cold slide, we have seen that the color does not appear for a minute or more with veratria unless the slide or the acid is warmed.

The color produced is also different, for with veratria it is, for a moment, a yellowish, *then* a beautiful bright red, then an intense blood-red color; with salicine it is more of a purple red. There is the difference between the two colors that there is between bright arterial and venous blood. The color produced upon veratria lasts

but two or three hours, while that produced upon salicine lasts double that time.

But the behavior with other reagents would definitely settle the point if doubts were excited.

In a correspondence with Geo. J. Scattergood, of Philadelphia, on this subject, he says: "By treating commercial veratria with ether I have separated it into two substances. That portion insoluble in ether behaves with sol. of iodohydrarg. potass., and with tr. iodine, on a muriate boiling, and sal ammonia added while yet warm, differently from the way pure veratria does.

"Veratria, soluble in ether, gives a beautiful pink-red or crimson color with sulphuric acid, and a butyric acid smell; the matter insoluble in ether gives a darker color, a greenish or brownish-red, and a musky odor."

It will thus be seen that in following the experiments of Prof. Wormley with veratria obtained from Veratrum sabadilla, we have obtained almost identical results with the veratria we have made from Veratrum viride; and have thus confirmed Mr. Richardson's observations, that the two alkaloids were identical in their chemical reactions.

NOTE.—"Extraction of Veratrine by Ether and Chloroform.

"1. The chloride of veratrine. One grain pure veratrine dissolved in 100 grains of water by the aid of hydrochloric acid, and then the solution agitated for several minutes with an equal volume of ether; the ether then drawn off and evaporated to dryness, leaves a residue of 3-100th grain of chloride of veratrine.

"One grain of veratrine in 100 grains water, by the aid of hydrochloric acid, and agitated with an equal volume of chloroform, and the chloroform evaporated to dryness, leaves an opaque vitreous residue of 33-100th grains of chloride of veratrine.

"2. Pure veratrine. One grain of veratrine dissolved by hydrochloric acid in 100 grains of water, and the solution rendered slightly alkaline by potash solution, gives a copious white precipitate, so dense as to make the liquid almost gelatinous. If now the mixture be mixed with an equal volume of ether and agitated for several minutes, and then the ethereal solution evaporated to dryness, it leaves a transparent vitreous residue of 91-100th grain of pure veratrine.

"When one grain of veratrine is treated as above and agitated with an equal volume of chloroform, and the chloroform solution evaporated to dryness, it leaves a perfectly transparent vitreous residue of 97-100th grain of pure veratrine."—From *Ohio Med. and Surg. Journal*, vol. xii., No. 6, p. 464, by Prof. Wormley.

DIVISION FOURTH.

DOSE AND MODE OF ADMINISTRATION.

By consulting other parts of this monograph it will be seen that the dose of the concentrated tincture (the formula for which is given in the first division of this section) varies in quantity and frequency of repetition according to the effect desired to be produced.

I shall be exceedingly explicit upon this point throughout the whole of the fifth section, and shall, therefore, need but few words at this place.

As an arterial sedative the dose, to an adult, may usually be from 2 to 3 minims, repeated every one, two, or three hours, according to the effect upon the pulse.

If it be deemed advisable to bring the patient promptly under its influence 3 minims may be given every hour until the pulse indicates its sedative influence, which will generally be felt before the third hour; it may then be repeated either in smaller doses or at longer intervals, but it will produce less unpleasant effects in small doses frequently administered, than in large ones at longer intervals.

Large doses are apt to produce vomiting, paleness, and alarming prostration, and the physician is frequently called in haste in consequence of the unpleasant effects of them. Nearly all instances of alarm have been produced by large doses, and not by small ones frequently repeated. Large doses, also, do not so readily control the circulation, as excitement and vomiting supervene, and the pulse sometimes becomes thready, frequent, and irregular.

With children it is especially necessary to give it in small and frequent doses rather than in large ones at long intervals, and if administered in this manner alarming effects will seldom be produced.

Children, from the activity of the circulation and rapidity of excretion, will bear a rather larger proportional dose than adults; thus a child eight years of age will bear about one-half the dose an adult will. To a child of that age 2 minims may be given as a first dose, and one minim may be repeated afterward every one or two hours according to its effect upon the pulse. Unless in very urgent

cases it is not advisable to bring the pulse more than 10 or 15 beats below the normal standard, and to do this it is but required to increase or diminish the dose according to the state of the pulse, and give it at intervals of one or two hours rather than at longer periods.

With adults a given number of minims may be put into a given number of teaspoonfuls of water, and one or more teaspoonfuls given at a dose.

With children it is more easily given in sweetened water, or sweetened water and orange juice, or syrup of tolu.

SECTION THIRD.

PHYSIOLOGICAL ACTION ON ANIMALS.

DIVISION FIRST.

EXPERIMENTS ELUCIDATING THE PHYSIOLOGICAL ACTION OF VERATRUM VIRIDE ON ANIMALS.

EXPERIMENT I.—Ten drops of the concentrated tincture put into a gelatine capsule, were passed down the throat of a mongrel dog weighing about twenty pounds; the dog had eaten nothing for six hours, and the pulse was beating 90 in the minute. In an hour and ten minutes after taking it, the dog vomited freely, and twice afterwards. In an hour and a half after the dose was given, the pulse was 60; in two hours and a half, 53. In four hours it had risen to 56; the dog seemed well, and ate heartily.

EXPERIMENT II.—Twenty drops of the same tincture were given to a dog who had been fasting for twelve hours. In an hour and seventeen minutes he vomited, and continued to strain and vomit for some time. At the expiration of two hours and a half, the same dose was repeated, the pulse then beating 61 in the minute. The dog, exhausted by the previous vomiting, lay down and did not attempt to stand up. In four hours from the administration of the first dose, the pulse was 29 in the minute, and the dose was again repeated. The retching was frequent, but nothing but a small quantity of viscid mucus and bile was thrown up. In five hours from the administration of the first dose, the pulse was 21, soft, creeping, and easily compressible. The pupils were fixed, but of ordinary size. They did not contract in strong light, but the lids were closed if anything was pointed at the eye. The dog would not move when struck with a switch. Six hours from the first dose, the twenty drops were repeated, the pulse being then 18, and intermittent. At the seventh hour there was great prostration, the retching continued, the pulse was irregular, intermittent, and easily compressed, and beating 17 in the minute. The dog would

remain in almost any recumbent position he was placed, and his limbs were moved without an attempt at resistance. The lids would close if the eyeball was touched, otherwise they remained open; the eye had a fixed, staring, lack lustre look.

The dog was then left, and I did not see him again for twelve hours, during which time he drank two quarts of water. He seemed very feeble, and would come upon being called. The pulse was 149 and soft. He ate freely of meat, and later in the day seemed well, but sober, the pulse not exceeding 83 after his meal.

Experiment III.—Two drachms of the same tincture in capsules, were enveloped in meat and given to a small dog. The pulse was 87. In two hours and twenty minutes he vomited some milk that had been taken just before the medicine, and threw off finally, all the contents of the stomach. In three hours the pulse was 39. After twenty-four hours, during which he was fed, he seemed quite well and lively.

Experiment IV.—The same dose was given in the same manner to a dog, and immediately afterwards a pint of melted lard was thrown into the stomach with a syringe. The pulse was 92. In three hours and five minutes the dog vomited, and the retching was prolonged and prostrating. In six hours the pulse was 44, and the prostration very great.

Experiment V.—An ounce of the tincture, evaporated down to a soft extract and enveloped in a thin slice of meat, was given to a small dog who had eaten nothing for twenty-four hours. The pulse was 97, sharp and irritable. In thirty-eight minutes he vomited the meat with some fluid and mucus, and some of the extract. The pulse had fallen to 78. The vomiting continued, bringing up some frothy and bilious-looking matter. In two hours and a half the pulse was 55, and it did not at any time fall below 48. The prostration was less than in the two previous experiments. No doubt the greater part of the extract had been thrown up.

Experiment VI.—Twenty minims of the same tincture were passed by one of Wade and Ford's hypodermic syringes, into the femoral artery of a dog, whose pulse was at 85. In one minute he fell upon his side quite powerless, the eyes became dull and fixed, and the lids did not close on touching the cornea. In five minutes every sign of life was extinct.

Autopsy immediate. The heart's action had ceased; but upon

making an opening into the aorta, a large quantity of blood was thrown out, and the heart's contractions were renewed feebly for several seconds. Both right and left heart were filled with blood. The blood coagulated.

Experiment VII.—Into the cellular tissue of the right lumbar region of a mongrel dog weighing sixteen pounds was passed, by Wade and Ford's hypodermic syringe, ten minims of the concentrated tincture. The pulse at the time was 110. The movements soon became uneasy and unsteady. In eighteen minutes the dog vomited, and the pulse was reduced to 63. In thirty-four minutes the dog staggered, lay down, and was unable to rise, the retching continuing frequent. In thirty minutes the dog lay completely on its side, and the saliva flowed very freely from his mouth. The eye was dull, the pupils widely dilated, but fixed; but the eye closed if the cornea was touched. The limbs were very flaccid, the pulse 32. Ten minims more of the same tincture were now injected into the left lumbar region. In forty-five minutes from the first injection, the heart was beating 14 in the minute, and very irregular; the saliva continued to flow freely from the mouth, being almost as limpid as water. *The dog was perfectly insensible to pain.* The respirations were slow but full. At one hour from the first injection, the heart merely fluttered; the dog could be moved in any way without the slightest *voluntary* motion. The urine and feces were passed involuntarily. I now threw into the stomach, with a syringe, a pint of warm milk punch, containing four ounces of brandy, and ten grains of carbonate of ammonia. In ten minutes the pulsations, though irregular, could be felt distinctly, in eighteen minutes the heart was beating regularly 30 in the minute, and in two hours the dog was walking about, but with a very demure and sober appearance. The pulse was then 55. The next day he had quite recovered.

This dog was peculiarly susceptible to the influence of the medicine. I have repeated the same experiment on other dogs, but with nothing like the same amount of prostration resulting.

Experiment VIII.—Ten minims of the tincture were injected into the cellular tissue of the hind leg of a rat. In eleven minutes I took him out of the cage, and he suffered himself to be handled without making any resistance. On replacing him in the cage, he would remain in any position in which he was laid, without moving. The next day he was running about apparently as well as ever.

EXPERIMENT IX.—To a large, coarse mongrel dog was administered, by injection into the stomach, one ounce of the tincture, in about eight ounces of good beef soup. The pulse was 142. For about fifteen minutes he seemed quite well, but soon after showed signs of uneasiness, walking about with a dejected air, and constantly lying down and rising again. In forty seven minutes he vomited violently, throwing off the contents of the stomach with great force. This continued for some time. At one hour from administration, the pulse was 63, at two hours, 40. Two drachms more of the tincture were then administered. In about fifteen minutes the vomiting was again excessive. In three hours from the first administration he lay still and quiet on his side; the pulse was 34, the pupils were fixed and without expression. The saliva flowed very freely, and was saved for future experiment. In four hours from the first administration I injected, by the hypodermic syringe, twenty minims of the tincture into the femoral artery. In a minute and a half he was dead.

Autopsy immediate. The bladder contained two and a half ounces of urine, which was saved. The chambers of the heart on each side were filled with fluid blood. The lungs were congested, while the mucous membrane of the stomach was but very slightly so.

EXPERIMENT X.—This urine, diluted with about the same quantity of water, was thrown into the stomach of a cur weighing seven pounds. The pulse was 144. In an hour and thirty-five minutes the dog vomited a small quantity of frothy mucus. The pulse was then 97. At two and a half hours it was 83, and at three hours, 73.

EXPERIMENT XI.—At the same time with the last experiment, the saliva was administered to another cur of the same size. This saliva measured eight fluidrachms. The pulse was then 127. In one hour and thirty-five minutes the pulse was 82. At two and a half hours, 70; at three hours, 59. This dog did not vomit.

EXPERIMENT XII.—To a small cur dog, when the pulse was 140, I administered, in a piece of meat rolled up, fifteen minims of the tincture, with one-quarter grain sulphate of morphia. In one hour the dog was very still and quiet, the pulse 112, and the respirations easy and full. I repeated a five minim dose of tincture of veratrum combined with one-eighth grain of sulphate of morphia every hour for five hours. In six hours there had been no vomiting, the pulse was 45, and the respirations slow, less frequent than without the morphia. The pupils were contracted. The morphia here overpowered the veratrum. At the expiration of ten

hours there had been no vomiting; the pulse was 46. The effects of the morphia still continued, and the dog was roused with difficulty.

Experiment XIII.—Two drachms of the tincture were thrown into the stomach of a cur dog weighing about nine pounds. In forty-eight minutes the vomiting was very free. I now injected into the cellular tissue, under the fore leg, one-quarter grain of sulphate of morphia in solution. In a few minutes the vomiting ceased, and the dog lay down and slept for several hours. In three hours the pulse was reduced to 100 beats in the minute. The pupils were contracted. I have repeatedly administered codea in doses three times larger than morphia, but without as marked beneficial results.

Experiment XIV.—Five minims of the tincture were injected into the cellular tissue, around the left eye of a cur dog. The pupils were watched for three hours, but there was no appreciable difference between them, both were dilated.

Experiment XV.—To a strong, coarse cur was administered $\frac{1}{12}$ gr. of the acetate of strychnia; the pulse was 129. In five minutes the pulse had increased to 167, irritable and wiry. Two drachms of the tincture of veratrum viride were now thrown into the stomach. There were frequent and violent twitchings of the muscles, more particularly in the lumbar region and hind legs. In half an hour the pulse was 160. The pulse continued gradually to fall, and the convulsive actions to grow less, until at 2 hours and 17 minutes he vomited. From this time there were no more twitchings, and in four hours the pulse had fallen to 83.

Experiment XVI.—To a strong coarse cur, weighing about 25 pounds, was given $\frac{1}{4}$ gr. of strychnia. He had had nothing to eat or drink for 24 hours. The pulse was 131. In fifteen minutes he was violently convulsed; the pulse could not be counted. I now injected into the cellular tissue over the cardiac region, one drachm of the concentrated tincture of veratrum viride. In 30 minutes after, he vomited, and the pulse could be counted, being 126. The convulsive movements grew less and less violent, and in one hour and thirty minutes had ceased. The prostration was not great, and the pulse did not sink below 100.

Experiment XVII.—The same dog, by means of the veratrum viride, was brought into the condition described in Experiment II. When perfectly prostrate and unable to make the slightest resistance, $\frac{1}{6}$ gr. of the acetate of strychnia was thrown into the sto-

mach; the pulse was then only 17 in the minute. In 16 minutes, he gave one strong convulsive movement, and stood upon his feet, with an alarmed and wild appearance; the pulse had risen to 46. He lay down again, and did not attempt to move for two hours; the pulse was 84. Late the next evening I gave this dog 1½ gr. of the same strychnia, without being accompanied or followed by veratrum; in the morning he was dead and very stiff. See Expt. No. IV., p. 247.

These experiments with strychnia have been repeated many times, but *great* caution is necessary, for an overdose of strychnia quickly causes death. Veratrum is only antidotal to a certain point.

Experiment XVIII.—To a cur dog, weighing about 12 lbs., the tincture was administered in repeated doses, as in Experiment II., until the pulse was reduced to 26 beats in the minute. The electro-magnetic apparatus was then applied, one pole being placed under the fore leg of the left side (where there was very little hair), between it and the body, and the other pole in the same position on the hind leg of the opposite side. The convulsive twitchings produced by this were for some time quite feeble, but by continuing the current they became stronger, and in 15 minutes the pulse had increased to 32 beats. Upon suspending the application of the instrument, the pulse again fell to 26, but five minutes after its re-application the dog had to be held, to restrain its struggles. After continuing for five minutes more he was able to stand, and in ten minutes more he walked about. The pulse had risen to 56.

Experiment XIX.—Two dogs of about equal size were brought into nearly the same condition as described in Experiment II., by the tincture of veratrum viride. One of them was kept in a warm room all night, and the other was put into an open yard. (This was in Jan. 1857, and the temperature about 24° F.) In the morning the dog confined in the room had nearly recovered, while the one exposed to the cold was dead and frozen. This experiment was performed to ascertain whether death would be caused while diminishing the temperature of the body. As the pulse was very slow, the animal heat was necessarily diminished, and when the dog was exposed to a temperature below freezing point, it was not able, under the depressing influence of the medicine, to maintain its animal heat, and consequently it died from the effects of cold. This fact should teach us the necessity in cases of poisoning with this medicine, with other arterial sedatives, or in cases of profuse hemorrhage, of keeping the patients in a warm and comfortable

room; for if they are in a cold place their temperature may be dangerously diminished, whereas no great diminution of animal heat will be experienced if they are kept in a warm place.

Experiment XX.—To a dog of about 16 lbs. weight the tincture was administered, in repeated doses as in Experiment II., until the pulse was reduced to 31 beats in the minute. A teaspoonful of tincture of cantharides was then given in a little water; the vomiting and retching were quickly suppressed; in 7 minutes, the pulse had risen to 42—in 15 minutes it was 49; a teaspoonful dose of tincture of cantharides was then repeated. In half an hour from the administration of the first dose the pulse was 54, and the dog seemed in a great measure to have recovered from his depression. This same experiment was repeated seven times with this dog, with very similar results. The tincture of cantharides did not produce strangury, even when pushed to ʒiv within the hour.

To another dog it was administered three times, after the depressing effects of veratrum viride, in doses of ʒij twice repeated at an interval of 30 minutes, and it quickly relieved the depression and the sinking pulse, but produced a hard and frequent pulse, many beats quicker than when the experiment was commenced. There was also, with this dog, at each experiment, great thirst, but no strangury or purging; at the two last trials there was priapism.

Experiment XXI.—To a large dog, weighing about 30 lbs., ʒiss of tincture of cantharides was administered every 15 minutes until ʒix were given. The pulse at the first dose was 93 in the minute; it gradually increased, becoming hard, wiry, and too rapid to count. In 2 hours and 40 minutes he had a bloody stool, evidently accompanied by severe abdominal pains; the respiration was hurried; there was great thirst, and painful priapism. At the expiration of three hours from the administration of the cantharides, ʒj of the tincture of veratrum viride was given. In 18 minutes the priapism had ceased, and apparently the abdominal pains also. In 30 minutes the pulse could be counted, 114 in the minute. He now vomited once, throwing up a quantity of water; he then lay down, and did not move for two hours; the pulse was at that time 89. The next day he seemed quite well.

Upon this dog this experiment was repeated four times, three times with somewhat similar results as above stated, the resinoid tincture being given. On the fourth trial, but little water was given him, and he died in convulsions before the veratrum viride could be

administered. The kidneys, bladder, and mucous membrane of the stomach and intestines were much congested.

Of the different medicines I have administered, these two, veratrum and cantharides, seem to me to be the most directly antidotal, and wherever I have found an inordinate degree of depression caused by any of the preparations of veratrum viride, I have obtained the quickest and most complete relief from these symptoms with cantharides. I have administered it twice with equally beneficial effects in the human subject.

Experiment XXII.—A cur dog, troubled with hydrocele of the left testis, was brought to me. I withdrew the fluid by means of Wade & Ford's hypodermic syringe, and injected into the cavity 20 minims of concentrated tincture diluted with one drachm water. It was three hours after the operation before any effect was noticed upon the pulse, and its greatest diminution in five hours was only 20 beats in the minute. The dog was kept, and in two weeks the cure of the hydrocele was complete.

Experiment XXIII.—One fluidounce of blood was drawn from the femoral vein of a large cur dog into a graduated glass. Twenty minims of the tincture of veratrum viride was then administered by hypodermic injection, and in one hour after another ounce of blood was drawn in, as nearly as possible, the same manner into a similar graduated glass. Both were put aside, and in six hours it was almost impossible to tell them apart.

Experiment XXIV.—A fluidounce of blood was drawn, under like circumstances, from a small cur dog. An ounce of the tincture was then thrown into the stomach with a little water. In 1½ hour there was vomiting. The same quantity of blood was then drawn as before, and both were set aside until the next morning (7½ hours). There was scarcely any difference in appearance.

These experiments were performed in order to ascertain whether veratrum viride, like many of the salines and antimonials, diminishes the amount of fibrin in the blood or causes any difference in appearance. The results would indicate that it does not.

Experiment XXV.—A compress was applied to the femoral artery and a strong ligature tied very tightly around the right thigh of a small dog, the nerve having been dissected up and left out of the ligature. Two drachms of the tincture were thrown into the stomach, and as vomiting was induced, one drachm of the tincture was thrown into the opposite femoral artery. Death ensued immediately. About an hour after the death of the animal, the muscles

were laid bare in several places and but little effect was produced upon them by galvanism; but upon the right leg below the ligature galvanism produced active movements of the muscles, as in death from ordinary causes.

This proves that the action upon the muscles is communicated through the blood and not through the nerves.

This dog, before the application of the ligature, was fully under the effects of chloroform.

EXPERIMENT XXVI.—To a small, quiet, and very easily managed pet dog, small doses were repeatedly given to see the smallest amount that would produce a noticeable effect upon the pulse; $\frac{1}{4}$ minim every hour would, at the expiration of five or six hours, make a slight difference in the pulse, but $\frac{1}{8}$ or $\frac{1}{8}$ minim at like intervals produced no effect.

Whenever I have found a dog more than ususlly quiet, I have repeated these experiments, and the limit at which it produces an effect is quite marked. The $\frac{1}{30}$ minim every 15 minutes for four hours produces no noticeable effect.

DIVISION SECOND.

EXPERIMENTS ELUCIDATING THE PHYSIOLOGICAL ACTION OF THE RESINOID PRINCIPLE OF VERATRUM VIRIDE ON ANIMALS.

EXPERIMENT I.—Five minims of the tincture, made from the *resinoid principle* alone, was injected by Wade & Ford's hypodermic syringe into the cellular tissue of the right thigh of a dog weighing about 14 lbs. The dog had eaten nothing for 14 hours. The pulse was 146. The same dose was repeated every fifteen minutes until eight doses had been injected; the pulse constantly and steadily diminishing.

Five minutes after the eighth dose, the dog lay upon his side and would make no effort to get up; the pulse was 32. Four minim doses were then injected into the opposite thigh every five minutes. The fourth dose was hardly given before the heart's pulsations ceased. Autopsy immediate. The heart was instantly exposed and both sides were found filled with blood. Upon the aortic valves, and forming a perfect network over them, were threads of fibrin, which adhered with much tenacity; but there was no appearance of inflammation and no doubt the fibrin had formed, in consequence of the sluggishness of the circulation, which

for some fifteen minutes before death counted only 8 in the minute. With this dog the flow of saliva was very abundant, and the urine was passed involuntarily before death.

Upon application of electro-magnetism, ten minutes after the heart was removed, the muscles were not excited into action. The lungs and mucous membrane of the stomach were congested. It was found that the last injection had passed into a vein.

Experiment II.—To a large cur dog, weighing about 25 lbs., 30 minims of the resinoid tincture of veratrum viride (containing 1½ gr. of resin) were thrown into the stomach at—

11.15	o'clock	A. M.		The pulse being	140
12.10	"	P. M.,	repeated 20 minims.	" "	117
12.20	"	"	free salivation.	" "	110
12.55	"	"		" "	84
1	"	"	vomited many times in quick succession, the latter vomit being a tough, ropy mucus and much bile; the vomiting was painful and prostrating.	Pulse	80
1.15	"	"	pupils fixed.	"	76
1.45	"	"	profuse diuresis and salivation.	"	72
1.47	"	"	vomited several times, viscid mucus and bile.		
3.30	"	"	sleeping.	Pulse	70

Experiment III.—To another dog, weighing about 20 lbs., ʒss of the same resinoid tincture, containing 1½ gr. of resin, was given on a piece of bread, which was thrust down the throat.

11	A. M.		Pulse	144
12	"	salivation.	"	124
12.20	P. M.		"	96
12.25	"	vomited many times, the latter vomit being viscid, ropy mucus and bile.		
12.50	"		Pulse	80
1.10	"		"	74
1.40	"	profuse diuresis, no dilation of pupils.	"	70
3.35	"	quiet.	"	40

Experiment IV.—Half a drachm of the same resinoid tincture was thrown, by the hypodermic syringe, into the cellular tissue under the fore leg of a dog weighing 25 lbs.

12.45	P. M.		Pulse 96
12.55	"	salivation.	" 72
1	"	vomited and freely purged; vomiting continued until viscid mucus and bile were thrown up, and then bile alone.	
1.15	"	intense uneasiness and cries caused by the painful contractions of the diaphragm in vomiting.	
1.30	"		Pulse intermittent 52
1.35	"	walks with unsteady and uncertain movements of the voluntary muscles, especially of the hind legs, which are kept wide apart.	
1.50	"	pupils widely dilated.	Pulse 40
3.30	"	salivation profuse, moaning cries and painful contraction of the abdomen, respiration 84.	Pulse 122

This dog was well the next morning.

Experiment V.—Twenty minims of the resinoid tincture were thrown into the stomach of a dog, whose weight was about 16 lbs., at 3.45 o'clock P. M., the pulse being 143.

In ten minutes it vomited, and the same dose was repeated.

4.20	P. M.		Pulse 62
4.35	"	profuse salivation, vomiting continued.	" 56
5	"	injected 5 minims into the femoral vein.	
5.05	"	purged freely.	
5.10	"	vomiting viscid mucus and bile, pupils widely dilated.	Pulse 36
5.17	"	gave 2 oz. of brandy in water.	" 34
5.20	"	no more vomiting.	" 46
5.45	"	" " repeated the brandy.	" 56
9	"	" " unable to stand, pulse thready, intermittent, could not be counted. During the next day it vomited several times, seemed in great pain, moaned, pulse could not be counted. Died during the night.	

Experiment VI.—Half a drachm of the same resinoid tincture of veratrum viride was thrown, by hypodermic injection, into the side of a large dog weighing about 30 lbs.

11.45	A. M.		Pulse 165
11.56	"	saliva flows very freely, purged, restless.	" 106
12.03	P. M.	vomited freely viscid mucus and bile.	

12.15	P. M.	purged again, vomiting.	Pulse 60
12.30	"	pupils widely dilated, vomited clear bile.	" 52
12.40	"	made an incision down to the femoral vein; he made no resistance and seemed to be unconscious of pain.	Pulse 41
12.44	"	injected 20 minims into the femoral vein, death was almost instantaneous. Both sides of the heart were *full* of bright chocolate-colored blood; the liver was *gorged with dark blood;* the mucous coats of the stomach and rectum were greatly congested; the other organs were healthy.	

EXPERIMENT VII.—Half a drachm of the same resinoid tincture was thrown into the stomach of a large dog; when he had vomited freely, and was in the condition mentioned in Experiments II. and III., one grain of sulph. morphia was given in solution. There was no more vomiting, the dog became easy and quiet, and in forty minutes was sleeping soundly; the pupils were much contracted. The pulse remained for several hours about the same as when the morphia was given. He was quite well next day.

DIVISION THIRD.

EXPERIMENTS ELUCIDATING THE PHYSIOLOGICAL ACTION OF THE ALKALOID VERATRIA OBTAINED FROM VERATRUM VIRIDE, AND FROM OTHER SPECIES, ON ANIMALS.

EXPERIMENT I.—Ten minims of a solution containing $\frac{1}{3}$ gr. of the alkaloid veratria made from veratrum viride, by Mr. George Scattergood, of Philadelphia, were given to a large dog weighing about thirty pounds, in gelatine capsules; great care was taken that none of it escaped into the mouth.

3.35.	P. M.		Pulse 150
4	"	salivation very profuse.	" 148
4.05	"	vomited.	" ——
4.20	"	vomiting very frequently.	" 140
4.45	"	vomiting viscid mucus and bile.	" 128
5.20	"	prostration very great, unable to stand.	" 122
5.45	"	pupils widely dilated, eyes fixed.	" 122
6	"	prostration great, profuse salivation.	Intermittent
9	"	walking about, but sober and dejected.	112

Three days afterward the same dose was again given to the same dog, with very similar results. With this animal, the pulse was not much depressed, the prostration was very great, and there was almost total loss of power of the voluntary muscles.

EXPERIMENT II.—One-third gr. of veratria (viride) was injected into the thigh of a dog weighing about fifteen pounds.

3.40 P. M.			Pulse 120
4 "	saliva flows most profusely, purged.		" 100
4.30 "	"	"	" 100
5.45 "	"	"	" 100
9 "	"	"	" 92

EXPERIMENT III.—A subcutaneous injection of $\frac{2}{3}$ gr. of veratria (viride) was given to a coarse dog weighing twenty-five pounds. He had been well fed, and was very lively.

3.35 P. M.		Pulse 116
3.40 "	very dejected appearance, free flow of saliva.	
4.15 "	repeated the injection of 1 gr. on the other side.	" 90
4.17 "	purged.	
4.30 "	saliva flows freely, very dejected.	" 82
4.35 "	vomited frequently, respirations labored, prostration very great, legs wide apart.	
5.15 "	prostration increases.	" 70
5.20 "	painful vomiting every few minutes, unable to stand, gave 2 oz. of brandy in water.	
5.30 "	no vomiting since taking the brandy	" 88
5.45 "	no vomiting, repeated 2 oz. of brandy	" 88
9 "	no vomiting, very prostrate, unable to stand, pupils dilated and fixed, repeated the brandy.	" 98
9. A. M.	Next day—unable to walk steadily, stands over the water lapping every few minutes.	
		Intermittent 170

Recovered during the next day.

EXPERIMENT IV.—A subcutaneous injection of $\frac{1}{3}$ gr. of veratria (album) was made into the thigh of a small dog, weighing about six pounds.

11.45 A. M.		Pulse 110
12.05 P. M.	vomited freely, purged freely.	" 175
12.20 "	vomiting continues.	" 180

12.22	P. M.	repeated the same dose, but on the other side.	
1.10	"	prostration very great, unable to stand.	Pulse 160
1.25	"	administered $\frac{1}{1}\frac{1}{2}$ gr. of strychnia.	Intermittent 80
1.21	"	in violent convulsions, of which he died in a short time.	

Experiment V.—Ten minims of a solution containing $\frac{1}{3}$ gr. of veratria purified with great care from some of Powers & Co.'s commercial article, were given to a dog, whose weight was about twenty-five pounds, in gelatine capsules.

10.	A. M.		Pulse 132
10.15	"	saliva flowing freely.	" 130
10.45	"	vomited several times in a few minutes.	
11.15	"	continues vomiting viscid mucus and bile.	" 126
12	M.	continues vomiting.	" 130
2	P. M.	continues vomiting, great prostration.	" 145
4	"	continues vomiting, great prostration, dilated pupils.	" 115
5.45	"	unable to stand.	" 100

Although walking about the next morning, he was dull and dejected, and ate but little, but drank water very frequently in small quantities.

During the months of July and August, 1857, I tried thirty-one experiments upon dogs with the alkaloid, made by myself from veratrum viride, and with the commercial veratria made by Merck, for the purpose of ascertaining if they were alike in their therapeutic action.

My principal object was to ascertain whether they produced the same sedative effect upon the pulse as the tincture of the veratrum viride.

From these experiments I learned that the alkaloid from the viride was more sedative in its effects upon the pulse than the commercial veratria; that it was less irritant, seldom causing an increase in the number of pulsations which the commercial veratria frequently did; that it produced vomiting and prostration in about an equal degree; that when a large dose was given, and prostration induced, there was most generally a dilatation of the pupils, but this effect was not produced by small doses; that purging was but seldom produced by either when given by the mouth, but nearly always when given by hypodermic injection; that large doses of

either, amounting to two grains at a time, might be given, producing alarming prostration, and most painful and protracted vomiting without causing death, if brandy, brandy and morphia, or tincture of cantharides was administered, and that in every instance the animal's life might be saved by proper attention.

In those instances where death took place from these alkaloids, it was caused by repeating the dose, and not by a dose of two grains administered at one time. Upon post-mortem examination the mucous membrane of the stomach was much inflamed, and in some instances the inflammation extended more or less through the whole intestinal tract, and was always seen at the rectum; the kidneys were in a state of congestion, and the heart filled with dark blood.

When the dose was given by hypodermic injection, the results were somewhat different, as will be seen by reference to Experiments II., III., IV., of Division Third.

Both alkaloids produced a sedative effect upon the pulse, but the commercial veratria did not to the same extent, as that from the viride, and neither of them to the same extent as the pure resinoid, or the tincture made from veratrum viride.

The prostration was more complete, alarming and prolonged, and the vomiting was more painful and continued from the effects of the alkaloids than from the other preparations named.

DIVISION FOURTH.

EXPERIMENTS ELUCIDATING THE PHYSIOLOGICAL ACTION OF VERATRUM VIRIDE ON FROGS AND BATS, BY THE EXAMINATION OF THE CIRCULATING BLOOD WITH THE MICROSCOPE.

As early as 1849 I experimented on frogs with veratrum viride, watching its effects upon the circulation of the blood with the microscope.

At that time my experiments were made by throwing the substance into the stomach of the frogs; since then I have repeated the same experiments, and have also used injection under the skin by means of the hypodermic syringe; and have experimented also by placing the frogs in water which was mixed with a certain amount of tincture of veratrum viride.

I had but one object in trying these experiments, and that was, to watch the effects of veratrum on the circulation; so it will be

unnecessary for me to relate a large number of instances, and it will save time, and be quite as easily understood if I give the general effects produced.

In these experiments it was my endeavor to subject the frog to as little annoyance as possible; it was placed in a coarse linen bag, and the frog plate had a raised edge around it, so that it would hold water to keep the frog always moist.

The bag had several holes at the end through which the mouth could be seen, and through which could also be introduced a small syringe, with a long nozzle, that would lead directly to the stomach.

The circulation of each frog experimented upon was always watched before any medicine was administered, and every precaution taken to ascertain the normal circulation. The effects of veratrum viride on frogs were the same as on man and animals—a direct sedative to the vascular system.

Doses of two minims of the tincture, diluted, when thrown into the stomach, with ten or fifteen drops of water, cause a marked diminution of the frequency of the circulation, in from three to fifteen minutes after administration, and the pulsations continue to decrease for one or two hours. If the water in which the frog lies is frequently changed so as to keep it cool, and the dose is repeated every hour, for two, three, or four successive hours, the effects may be watched until the circulation is so regular and sluggish that the blood globules may be counted as they course through the smaller vessels, and the difference between the white and red disks, and their position in the larger capillaries, may be easily discerned. Sometimes the circulation would almost entirely cease in the web, but would return again in ten or fifteen minutes if the frog upon the plate was placed in fresh running water.

It was always interesting to watch the cessation of the circulation and its re-commencement.

When large doses of the veratrum viride were given by the stomach, the cessation of the circulation never occurred suddenly. There would be intermissions of longer or shorter duration; after each one, the current of blood when re-established would be slower than before, and after a while would cease. After it had ceased there would be an occasional throb, which would cause a general movement, but upon the subsidence of the impetus, the blood disks would be in about the same situation as before.

The occurrence of this throb was the first notice given of the return of the circulation: it would be repeated at shorter intervals,

sometimes a minute elapsing, and then several of such pulsations would occur in a minute. Then a short but general movement would take place of the blood-disks; at each pulsation, ceasing upon cessation of the *vis a tergo*, and again renewed, until the circulation was entirely established in a slow but steady current.

I have frequently seen in the breaking up of this status, that the red disks do not, as in a normal state, occupy the central current only, but both red and white disks are mixed up heterogeneously, and some time elapses before the red disks again regularly take their place in the centre of the current.

By hypodermic injection the same results as have just been spoken of occurred, but with greater rapidity and with one-quarter the dose that was administered by the stomach.

One-half a minim thrown beneath the skin of the leg would produce the same amount of sedative effects in five minutes that two minims administered by the stomach would produce in an hour. I have frequently exposed both feet of the same frog, so that they could be examined separately, at the same instant by merely shifting the stage of the microscope. Into one leg I have injected two minims of the tincture, and the cessation of the circulation of that foot has been very sudden, whereas that in the other would be continued for some time, gradually becoming slower.

Sometimes within *one*, generally within five minutes, the frog is apparently dead, so far as the circulation in the web is concerned, from the hypodermic injection of from two to five minims of the tincture; but if placed in fresh water, leaving the head exposed to the air, the frog will generally revive, and frequently will entirely recover, though sometimes it will partially revive and after all die within a day or two.

With the frog, cessation of the heart's action is not so sudden and complete as in warm blooded animals, and they will bear a much larger proportional dose of veratrum viride.

The effects of veratrum viride on the circulation of the frog are seen with more satisfaction if it is administered in small and frequent doses thrown into the stomach. By hypodermic injection the effect is too sudden, but by the former method the circulation can be reduced gradually until it becomes so slow that the number of the blood disks passing in a given time may be ascertained, as well as their size and appearance.

Upon the bloodvessels (capillaries, as well as arteries and veins) Veratrum viride produces a sensible dilatation; and upon the blood

disks, the first effects are an endosmosis, an increase in their size; but as the effect of the medicine is continued to the second or third degree of its operation, there is an evident exosmosis, for they appear smaller in size.

I have noted these effects upon the bloodvessels and upon the disks so frequently, that I am satisfied of the correctness of my observations.

It is impossible, by any means known to me, to measure such differences in size, but an instructed eye can take notice of them, and although such effects may not be demonstrable to all, to one who will watch carefully and repeatedly, such differences may be seen.[1]

These effects are produced so as to be properly observed only by small doses frequently repeated to the proper point, but large doses overpower the action of the heart and bloodvessels, and cause a paralyzing effect, sometimes amounting to cessation of the circulation.

To satisfy myself more thoroughly on this point, I have placed frogs under the microscope in the method above stated, and after carefully examining the circulation, I have injected into the peritoneal cavity five minims of the tincture of capsicum, or cantharides, in a little water. The circulation was soon very much increased, and continued to increase with fearful rapidity.

After a time, as the blood was propelled through the vessels with greater rapidity, there was a sensible contraction in their size. It seemed as though the vessels feeling the *vis a tergo* braced themselves to meet the encounter. At this time I have administered veratrum viride by hypodermic injection. It exerted, in a few minutes, a marked sedative influence, though the pulsations were irritable and frequent. I have repeated the injection of veratrum at intervals, and closely watched the circulation.

It controlled the pulsations, though not to the same degree as in health, and with large doses would check the circulation entirely. As the vessels were contracted in one instance by the inflammatory state produced, they were more plainly noticed to dilate under the sedative effects of the veratrum.

Under these experiments (and I have repeated them many times) most of the frogs die of peritonitis; making it evident that if there are lesions, which produce an excited state of the circulation, a

[1] It is asserted that such differences can be measured. See Dublin Quarterly Journal of Medicine, Feb. 7, 1855.

mere lessening of the frequency and force of the circulation will not effect a cure. But I will discuss this subject further, under the head of Modus Operandi.

I administered veratrum viride several times to bats, and examined the circulation under the microscope. The dilatation of the bloodvessels was as plainly marked as in the frog.

When frogs were taken fresh out of the water, and the web placed under the microscope, I have frequently confined my attention to one small capillary vessel. This capillary, that before the administration of the veratrum allowed but a single blood disk to pass at a time (the disks moving in a single file), would, when under the influence of the medicine, so dilate as to allow two globules to move along together, not quite in line, but one slightly behind and at the side of the other; but, at the slightest obstruction, moving up in line, and at the moment of the re-establishment of the circulation the one that was behind the other, by a change, would frequently take the lead.

At one spot where there was a sudden bend or turn in the capillary vessel, but one disk would pass at a time, but not in the hurried manner noticed before the administration of the veratrum.

The movements of the disks by the operation of the medicine are rendered slow and orderly. The bloodvessels become passively dilated.

I have tried various medicinal agents both with bats and frogs, but principally with frogs, to ascertain which is the best and quickest antidote to remove this dilated state of the bloodvessels, and to increase the vigor of the circulation. I have found that the alcoholic stimulants have in most instances had the desired effect of increasing the vigor of the circulation, but, of all medicinal agents, tincture of cantharides is the most prompt and efficacious, as it not only increases the vigor of the circulation, but also induces as marked a contraction of the capillaries as veratrum does a dilatation, and that in this respect they are directly antagonistic. Codeia and other remedies have been used, but we shall speak of them all in their proper place.

SECTION FOURTH.

THERAPEUTIC APPLICATIONS.

DIVISION FIRST.

THERAPEUTIC APPLICATION OF VERATRUM VIRIDE WITH RELATION OF A FEW CASES IN POINT.

Case 1. Encephalitis. Louisa K., æt. 11 years.

This young girl is of remarkably good constitution, and has not had a day's sickness for six years.

On the morning of 4th of July, she was playing with her companions, and fell down the stone steps in front of the house, striking her head severely. She went into the house, complaining of pain in the head, and sickness at the stomach. Her mother kept her quiet until towards evening, when she allowed her to go to play again. During the evening one of her playmates pushed her down the same stone steps, and she again struck her head. She complained so much that her mother put her to bed.

During the next day she complained of lassitude, creeping chills, and headache, and I was called to see her about 5 P. M.

I found her suffering with an intense throbbing headache; she said that the pain was "inside the head;" the face was flushed, the eyes were injected, the right pupil dilated to nearly double the size of the left; there was great intolerance of light, it seemed to greatly increase the pain; there was much thirst, but the water she drank was vomited up almost as soon as taken; the skin was hot, the pulse was frequent and wiry, beating 174 in the minute.

Upon examining the cranium, I could discover no injury, except a small ecchymosed spot on the right temple. I administered 1½ gr. of podophyllin rubbed up with a little sugar.

Date.	Pulse.	Treatment.	Remarks.
July 5th, 6 P. M.	174	Con. Tr. Ver. Vir. mij.	
7 "	176	" " mij.	Occasional delirium.
8 "	174	" " mij.	Delirium more marked.
9 "	160	" " mij.	Vomited bile.
10 "	110	" " mij.	
11 "	93	" " mij.	Vomited bile.
12 "	79	" " mij.	Constant chattering delirium, talking about her head.
		" " mj.	
6th, 1 A. M.	80	" " mij.	Bowels freely open, discharge bilious.
2 "	72	" " mij.	
3 "	72	" " mij.	Bowels again opened.
5 "	76	" " mij.	
6 "	70		Noisy chattering delirium.
8 "	70		Bowels opened; lies quietly.
9 "	59	" " mij.	Asleep for nearly an hour.
10 "	48		Respirations easy.
11 "	44		Free diaphoresis.
12 "	41		Bowels again opened; talks incoherently.
1 P. M.	42		Right pupils still dilated more than left.
2 "	56	" " mij.	
3 "	58	" " mij.	
5 "	60	" " mij.	
7 "	62	" " mij.	
9 "	64	" " miij.	Constantly talking about her head.
10 "	54	" " mj.	
12 "	43	" " mj.	Quiet, but answers incoherently.
7th, 2 A. M.	48	" " mij.	Slept for twenty minutes.
4 "	51	" " mij.	
6 "	49	" " mij.	
9 "	60	" " miij.	
11 "	55	" " mij.	Quiet.
12 "	47	" " mj.	Slept for an hour and a quarter.
2 P. M.	55	" " mij.	
5 "	62	" " miij.	
7 "	54	" " mj.	
9 "	50	" " mj.	Repeated the podophyllin.
12 "	61	" " miij.	Slept for an hour and a half.
8th, 2 A. M.	47	" " mj.	Bowels freely opened.
4 "	53	" " mij.	Bowels again opened.
6 "	54	" " mij.	Pupils still of uneven size, though not so marked.
8 "	55	" " mij.	Asked where she was; says her "head feels queer."
10 "	62	" " miij.	
12 "	52	" " mij.	
3 P. M.	53	" " mij.	Slept for 1¾ hours.
5 "	56	" " mij.	
7 "	57	" " mij.	Speaks consciously when addressed, but is unwilling to be disturbed; remains quiet.
11 "	63	" " miij	
9th, 1 A. M.	55	" " miij	Slept for 2¼ hours.
4 "	55	" " mij.	
7 "	58	" " miij	
9 "	46	" " mj.	Says she has no headache.
10 "	50	" " mij.	Pupils of the same size, and contract when exposed to the light. Light produces no pain in the head.
1 P. M.	61	" " miij	
4 "	58	" " mij.	
7 "	57	" " mij.	Slept two hours.
10 "	62	" " miij	Has no pain.

As the little patient seemed so much relieved, the medicine was continued in two minim doses every three hours. The bowels were kept freely open by rhei et soda, and on the evening of the 10th all remedies were discontinued, but quiet and a low diet enjoined for several days, under which she recovered her usual health. During this treatment her only food was powdered crackers boiled to a jelly. The urine could not be collected. It will be seen, in the treatment of this case, that the child's tolerance of the remedy was very great; it was borne in larger doses than is usual with many adults.

There was no vomiting from the effects of the remedy, and particular caution was used throughout the whole time of treatment to prevent it, as the excitement caused thereby would probably increase the trouble of the brain, and compel the cessation of the remedy for a time. The vomiting that existed before and during the early part of the treatment was controlled by the sedative action of the veratrum upon the brain.

Case 2. Pneumo-pleuritis. Miss M. A., æt. 37 years, of a nervous, bilious temperament, good muscular development, weighing 134 lbs.; went to bed feeling slightly indisposed, and was annoyed on rising in the morning with frequent slight rigors. About 10 o'clock A. M. these rigors were succeeded by flashes of heat; the tongue became dry and parched with considerable thirst.

About 2 o'clock P. M. she had a severe chill, which lasted 20 minutes, and which was followed by much fever, with a sense of constriction across the chest, and a teasing, tickling, painful cough. About 4 o'clock P. M. she complained of a severe stitch in the right side, about two inches to the right of, and a little below the nipple. The pain and fever continued to increase, and the cough was troublesome. I saw her at 6 o'clock P. M., Oct. 10th. The pulse was 164, the skin hot and dry, the face flushed; had passed no urine since morning, and had had no operation of the bowels for twenty-four hours.

Upon examination by auscultation I could distinctly discover crepitation over the whole of the right lung; the left was unaffected. The vesicular murmur was heard in front, but not behind on the lower lobe of the right lung. I immediately administered a brisk cathartic, and applied a large hot poultice to the seat of the pain.

Date.	Pulse.	Respirations.	Treatment.	Remarks.
Oct. 10th, 6 P. M.	164	30	Tr. ver. vir. ♏v.	Passed 2 oz. urine, sp. gr. 1.018, which on standing deposited am. mag. phosph.
7 "	160	30	" " ♏iij.	
8 "	146	27	" " ♏ij.	
9 "	100	27	" " ♏j.	
10 "	94	27	S. morph. gr. ⅓ Tr. ver. vir. ♏iij.	
11 "	81	23	Tr. ver. vir. ♏ij.	Bowels open; urinated.
12 "	59	20		Pleuritic pain much relieved.
11th, 1 A. M.	57	20		I left with directions to give 2 minims every hour if the pulse rose to 80 or over, but it was not done.
6 "	96	24	Tr. ver. vir. ♏v.	
7 "	91	23	" " ♏v.	Pleuritic pain quite severe.
8 "	67	23		Vomited a viscid mucus. Crepitation still heard.
9 "	51	20	S. morph. gr. ¼.	Pleuritic pain relieved.
11 "	58	19	Tr. ver. vir. ♏ij.	Free diaphoresis.
1 P. M.	60	19	" " ♏ij.	Passed 14 oz. urine, sp. gr. 1026, acid.
3 "	61	20	" " ♏ij.	
5 "	66	20	" " ♏iij.	Bowels opened.
7 "	63	21	" " ♏iij. S. morph. gr. ¼.	Expectoration easy.
9 "	61	19	Tr. ver. vir. ♏ij.	Passed 9 oz. urine, sp. gr. 1027, acid.
12 "	67	20	S. morph. gr. ¼. Tr. ver. vir. ♏iij.	
12th, 3 A. M.	66	18	" " ♏ij.	
6 "	62	18	" " ♏ij.	Passed 11 oz. urine, sp. gr. 1026; bowels opened.
9 "	65	18	" " ♏iij.	No crepitation in upper lobe.
11 "	64	19	S. morph. gr. ¼. Tr. ver. vir. ♏ij.	Diaphoresis very free; expectoration easy.
3 P. M.	66	17	" " ♏iij.	With the last 2 hours 27 oz. of urine have been passed, sp. gr. 1024.
7 "	67	18	" " ♏iij.	
10 "	66	18	" " ♏iij.	

Upon auscultation at this time I found the crepitation had entirely ceased, excepting at a small circumscribed spot near the base of the lung; expectoration was free and easy, and had no rusty color. The veratrum was continued in doses of three minims every three hours, until the morning of the 14th, when all remedies were suspended, as the crepitation had ceased, and the normal respiratory murmur was heard over the whole lung.

It will be noticed in this case that the veratrum controlled the pulsation, but that it was necessary to combine it with morphia, to control the respirations, and relieve the nervous irritability of the system. It will also be noticed, that as the disease was

brought under control the urine increased not only in quantity, but also in specific gravity.

Any person who treats a case of pneumonia with this remedy, and daily examines the auscultatory signs, will be pleased to find that he can with ease hear every sound, and arrive at a correct diagnosis of the state of the lungs, when without this remedy the sounds will be obscure.

In the relation of the two preceding cases, I have given the treatment and noted the number of pulsations from hour to hour. In the experiments upon animals the number of pulsations in the minute are also frequently noticed. It would seem unnecessary, therefore, in the relation of the following cases, to be thus minute; but as there are cases in which this remedy produces to the friends of the patient, and sometimes even to the physician, alarming effects, I will take one of these as a type and relate it as I have the foregoing.

Case 3. Pneumo-pleuritis. William T., æt. 11 years. A dull boy of leuco-phlegmatic habit, whose mother died of phthisis, complained of a sharp pain on inspiration, in the lower portion of the right lung, and an uneasy, tickling cough. He had rested badly all night, and complained of alternate chills and fever. The skin was hot and feverish, the pulse 165, the respirations 32.

Upon auscultation, crepitation was heard all over the lower lobes of the right lung, and over a portion of the upper lobe of the left lung. He was reclining in a rocking chair, as he said it was hard to breathe when lying down.

About an hour before I saw him he had eaten a bowlful of warm bread and milk, so that I thought it better to give him no purgative medicine until after the food had digested. He passed about half a pint of urine of acid reaction and sp. gr. 1014.

Date.	Pulse.	Respirations.	Treatment.
Dec. 4th, 10 A. M.	165	32	Con. Tr. ver. vir. ♏iij.
11 "	165	32	" " ♏ij.
12 "	164	32	" " ♏iv.
1 P. M.	164	31	" " ♏iv.
2 "	160	32	" " ♏iij.

About 2.45 P. M., I was sent for in haste, as the boy had vomited the bread and milk, which smelt very sour and disagreeable. After vomiting he lay back, very pale and faint. When I saw him about 4 o'clock, the friends were very much alarmed, and had sent out for the first physician they could find; he told them the

boy was dying, and had sent to the druggists for brandy and carbonate of ammonia.

The boy was on his back, very pale, and looking like one who had lost a large quantity of blood. He was bathed in a profuse perspiration, which stood in drops upon his forehead and face; the hands were outside the bed covers, and were cold and very moist; the feet were covered, and were warm, and also very moist; the respirations were 19 in the minute, and the pulse 41, full and soft. Upon being spoken to he said that he felt free from pain, but sick at the stomach if he moved; he requested to be let alone, as he felt well if undisturbed.

I did not allow the brandy and ammonia to be given, but covered him and applied warm bottles to the hands and feet. I gave him nothing. At 5 o'clock the pulse was 44, the respirations 18; at 6 o'clock the pulse was 52, the respirations 18; at 9 o'clock the pulse was 62, the respirations 20.

He had slept for two hours. He passed about a pint of urine, slightly acid and sp. gr. 1026. I left directions to give him two drops of tincture of veratrum viride, every two or three hours through the night, according to the state of the pulse. At 8 o'clock the next morning the pulse was 60, and the respirations 19 in the minute; there was no crepitation to be discovered over either lung.

In this case, both the physician and the boy's friends were much alarmed, and they insisted on giving the brandy and ammonia; and had not the father sustained me, I should have been obliged to leave. I was in error that I did not administer an emetic to empty the stomach before giving the veratrum, and especially when I found that it produced no effect for some hours.

Case 4. I was called to attend a young woman with pneumonia of the left lung; she was between the eighth and ninth month of pregnancy. Her own pulse on my first visit was 152, and the pulsation of her fœtus too fast to count. At the expiration of eight hours, under the use of veratrum viride, her own pulse was 82, and that of her fœtus 112. The medicine was continued, and produced slight vomiting, after which her pulse fell to 58, and that of her fœtus to 88. On the third day after ceasing the medicine her pulse was 86, and that of her fœtus 164.

Case 5. Acute Rheumatism. J. D., æt. 37 years, of bilious temperament. Has had two severe attacks of rheumatism previous to

the present one. The first attack was treated several years ago by Dr. Warren, of Boston, and the patient was confined to his bed for seven weeks, and recovered from it, but with valvular disease of the heart. The bellows murmur is distinctly heard, and is audible with the first sound of the heart, in the carotids. During the second attack I attended him, and he was confined to his bed for fifteen days, the treatment being principally with aconite. The cardiac trouble was not increased.

Jan. 3, 1857.—The present attack was induced by riding in an open sleigh, and indulging too freely in eating and drinking on Jan. 1st. The pulse was 146, strong and full, the bowels constipated, the urine so scanty as to be almost suppressed, the tongue furred with a reddened margin, the skin hot and dry, the left knee very painful and much swollen, and he declares it to be more painful than ever before.

There was a sense of soreness and constriction over the heart, with an increase in the intensity of the bellows murmur. The urine was acid and of sp. gr. 1.021. I gave two grains of podophyllin rubbed up with liquor potassa and water, and determined to bring my patient as quickly as possible under the influence of veratrum viride, but felt the necessity of watching him very closely, as I feared that with valvular disease of the heart, and consequent obstruction, its pulsations might easily be reduced too low.

I remained with my patient the first eight hours, and gave the veratrum in small and frequently repeated doses, carefully watching its effects upon the circulation. As he came under its influence the sounds of the heart were determined with great exactness, previously the sounds were tumultuous and inappreciable.

When I left, the pulse was beating 80 in the minute, soft, full and more regular; the palpitations had nearly ceased, as well as the sense of soreness and constriction about the precordia. The bowels had been freely acted upon. The urine had passed more freely, the skin was moist, and the knee, which was covered with oiled silk, was somewhat easier. The urine was acid, and sp. gr. 1023. I left the patient in the care of a very intelligent friend, who administered the veratrum in doses sufficient to keep the pulse about eighty.

4th. During the whole of this day, by means of the veratrum, the pulse never exceeded 80, and twice it was found to be as low as 72. The pain was very much diminished, so that he was enabled to sleep.

The feverish condition of the mouth was much relieved. The bowels were again opened, and the discharge bilious. The urine was more free, of dark color and acid reaction, of sp. gr. 1.027.

5th. The patient is very much easier, and allows the knee to be washed and moved without much complaint; the swelling and redness have diminished.

The pulse during the twenty-four hours was kept about 75, by administering the veratrum every one or two hours, according to necessity. He has slept fully half the time. Urine slightly alkaline, of sp. gr. 1.032.

6th. This morning I found my patient in his dressing gown, and sitting in his easy chair; he walked up and down the room several times; the soreness in the knee was quite gone, but as it existed to a slight extent in the ankle, I concluded to continue the veratrum for twenty-four hours longer, keeping the pulse at a maximum of 80. The podophyllin and liquor potassæ were repeated, and produced nausea and free purging. Urine alkaline, sp. gr. 1.028.

7th. The patient declared himself quite well, and the veratrum was discontinued. He asserted that for four years he had not felt so free from trouble about the heart.

The bellows murmur was much softer in its sound, and as the pulsations were more slow and regular, it could be more distinctly appreciated. (See Case No. 10.) I wished to continue the use of the veratrum for some time, in doses sufficient to control the pulsations, but at longer intervals, to see if it would have any effect on the valvular disease, but the gentleman was unable to remain with me any longer.

I have since then, whenever time and opportunity would permit, used veratrum in investigating diseases of the heart and aneurisms, and those who have not tried it for those diseases will be pleased to find the assistance it renders to a clear diagnosis.

For some four years previous to 1850, I used aconite for most of the cases of rheumatism that came under my care, being instructed in this treatment by the study of Dr. Fleming's most admirable treatise on that plant, but since 1850 I have used veratrum viride in cases of rheumatic fever, unaccompanied with neuralgia, with much better success than aconite.

There are cases of rheumatic fever with more neuralgiac difficulty than is common in the disease; in such cases skilful combinations of aconite with veratrum viride have given quicker relief

than either remedy alone. Aconite is a preferable remedy, for that form of neuralgic or irritative rheumatism, unaccompanied by high arterial excitement.

For several years I have treated cases of acute rheumatic fever with veratrum viride, and with better results than with any other remedy, and the case above referred to is not by any means a solitary one upon my note-book, in which the disease was relieved in a few days. With many of these cases I have used morphia in combination with it. With most of them, an alkali has been given at least once in the twenty-four hours, for the purpose as before expressed, of relieving the irritability of the stomach, and preventing nausea and vomiting from the veratrum.

In cases of rheumatic fever, the urine generally becomes neutral, under the proper administration of veratrum viride for forty-eight to sixty hours.

In this, as in other diseases of the heart, the abnormal sounds could be more easily estimated as the patient came under the influence of the remedy; prior to its sedative action a correct diagnosis was exceedingly difficult.

Case 6. Mammary Inflammation. I attended a stout muscular young woman in her confinement. About the tenth day, from neglect on the part of the nurse, there was much trouble with the breast, and I feared a mammary abscess. In addition to other treatment, I administered a full dose of veratrum viride, and repeated it in an hour. In one hour and three-quarters from the time the first dose was given, free vomiting took place. After the vomiting ceased, the veratrum viride was continued in as full doses as she could bear, and the pulse kept at about 50 beats in the minute all that night.

Early in the morning the child was allowed to nurse. About an hour afterwards I was called in haste, with the message that the child was dying. I found it in a prostrate condition, with a very low pulse. It had vomited many times, and was still retching. A little warm gin and water soon revived it.

The woman's breast was doing well, with much less pain and inflammation. Her sister, who was in the same house, and who had a babe but a few weeks old, promised to nurse this babe also.

I continued with the veratrum, and determined to try if I could get proof of the fact that the medicine had caused the babe's vomiting. A few hours afterwards, I drew out all the milk I could from both breasts, amounting to about 6 oz. I brought away a 4 oz. vial

full, the balance I gave to a kitten. It made the kitten very sick, and caused it to vomit several times. By adding acid I coagulated the milk, and filtered off the whey, which was evaporated. The extract was treated with chloroform, filtered and allowed to evaporate; this was then treated with ether and again allowed to evaporate; the residue was treated with alcohol and evaporated.

To an acid solution of this filtrate, a solution of chloride of gold was added, which produced a turbidity of a yellow color.

With the tincture of iodine, a small brown precipitate was formed. Tannin, and ammonia produced a white precipitate.

All the urine which had been passed for sixteen hours was filtered and evaporated, and the residue treated as above mentioned, with the same results, but more marked. Here then was proof that the veratrum had been absorbed into the blood; had produced its characteristic effects, upon the child and upon the kitten, through the milk, and it was chemically detected in both milk and urine.

The doses administered were, in this case, large; they were long-continued, and produced the characteristic depression of the pulse. The inflammation of the breast was promptly relieved.

Case 7. Chorea, or Acute Hysteric Chorea.

Anna W., æt. 14 years. I had cured this young girl of chronic chorea about one year and a half ago.

At the commencement of the present attack, the girl was in the country with her mother. After a day of unusual fatigue, spent at a picnic, the child was entertained with ghost stories in the evening.

She slept but little that night, and the convulsive movements of chorea commenced in the right side. During the day the convulsive movements increased, and the child expressed a constant dread of something, and was unwilling that her mother should leave her side for a moment. She slept none during the next night. In the morning, upon her mother leaving her for a minute she screamed violently, and from that time the convulsive movements increased in intensity.

She passed another sleepless night. Dissatisfied with the medical treatment she received, her mother left the country and brought her with her, but with difficulty made the change from the cars to the carriage.

When I saw her she looked in a truly pitiable condition. She had not slept for over sixty hours; it was with great difficulty that she

could swallow a teaspoonful of water; her eyes were injected, and had a glassy stare; the pupils were contracted; the face was suffused; the pulse thready and very rapid.

The convulsive movements were almost incessant, every muscle seeming to be in perpetual motion.

The hypodermic syringe was in my pocket, and I at once threw into the cellular tissue of the right arm five minims of concentrated tincture of veratrum viride. I left for about twenty minutes, to get some morphia and other remedies that I thought I might need. When I returned the child said she felt easier, and there was a slight improvement in her appearance. The same quantity of veratrum was repeated in the same manner.

In an hour from the administration of the first dose the pulse was slower and softer, but could not be counted, owing to the muscular movements. She expressed sensible relief, and took a small quantity of farina gruel. About fifteen minutes afterwards, she said she felt sick at her stomach; large drops of perspiration stood upon her face and forehead; the convulsive movements continued to grow less, and she said she felt free from pain. She did not vomit, but felt quite sick if she moved.

I assisted her to undress, and by smoothing her head, induced her to keep quite still, and shut her eyes. In two hours and seventeen minutes from the time of giving the first hypodermic injection she was asleep.

I allowed her to sleep two hours, and then roused her to give her some soup with $\frac{1}{8}$ gr. of morphia, and two minims of tr. veratrum.

While awake, the convulsive movements were renewed, but in a moderate degree. She soon went to sleep again.

After sleeping three hours she was again awakened, and had a large warm injection administered, as her bowels had not been opened during the attack. The injection brought away a large quantity of hard fecal matter. She remained awake about an hour. I administered three minims of tr. veratrum, and $\frac{1}{8}$ gr. of morphia, in an aperient mixture.

She went to sleep at 2 o'clock A. M., and was not awakened until 6 o'clock. The convulsive movements had then nearly ceased.

I continued the veratrum combined with iron and quinia for some time. The disease has not since returned.

Case 8. Facial Neuralgia. I was called to see a stout plethoric servant girl, and was told that she was suffering with acute face-

ache. I found her suffering with acute facial neuralgia, the pain extending over the whole of the right side of the face, with toothache and earache. Her features were quivering with pain; she seemed unable to be quiet for a moment, and she declared that she had not slept for two nights. Her pulse was 147 in the minute. With the hypodermic syringe I injected six minims of the concentrated tincture of veratrum viride, under the angle of the jaw. In two minutes, she said the pain was gone, and only the soreness was left. The girl was almost frightened at the quick relief, and declared it to be a miracle.

I gave her a full dose of purgative medicine, and sent her to bed. The relief was permanent.

Case 9. Sciatica. A stout laboring man, of scrofulous appearance, whose leg had been broken, complained of acute sciatica. I injected with the hypodermic syringe five minims of concentrated tincture of veratrum viride into the popliteal space. The relief was almost immediate, and continued nearly five hours. As the pain returned, the same dose was repeated with like effect, the relief lasting four hours. The same dose was again repeated, but with the administration by the mouth of two grains each of pulvis ferri and sulph. quinia every hour. The pain did not return.

During the first nine hours the pulse decreased 72 beats in the minute; there was no vomiting, but much nausea.

Case 10. Valvular Disease of the Heart. (See Case 5.) E. J., æt. 38. A stout muscular laboring man, who had until within a few months been a sailor. He has been living for the past two months in a dark unventilated basement.

When I was first called to see him, he was suffering with the first stage of pneumonia, which was plainly diagnosed by the physical signs. The dyspnœa was very painful. The pulse was wiry, intermittent, and too rapid to be counted. On applying the ear over the heart, a murmur was heard, but with which sound it was impossible to determine; there was also distinct intermission with every few beats of the heart; this, with the murmur, could be easily distinguished upon the opposite side of the chest.

He said he had not felt as well as usual since he had lived in this place, and attributed it to the want of sea air rather than to the dark, damp, and unventilated condition of his room.

About four years previous to his present sickness, he had a very severe attack of acute rheumatism, which, as the doctor had told him, had left him with disease of the heart; but it had not troubled him to any very great extent.

As the pulsations were so exceedingly rapid, and as there was probably organic derangement of the heart, I put him with other treatment upon the use of moderate doses of veratrum viride, to control the circulation, and to enable me to ascertain the cause of the intermittent pulsation and cardiac murmur. By the use of the veratrum, the pulse was reduced in twelve hours to about 60 beats in the minute, with an intermission every eighth or tenth beat.

The veratrum was continued until the pulse was about 50 in the minute, the murmur could then be heard very distinctly. The diastolic impulse was feeble and irregular, followed by a purring thrill that was heard distinctly towards the apex of the heart: this, from the slowness of the heart's movements was heard quite distinctly from the louder murmur that followed the systole. This systolic murmur could be heard by applying the ear over the right lung, especially beneath the clavicle, but its greatest intensity was at the base of the heart, and also in the carotids, and became less easily distinguishable towards the apex.

By the slow action of the heart these two sounds could be separated, and heard with great distinctness; the one at the apex, and the other at the base of the heart. They denoted valvular disease with regurgitation in both the mitral and aortic valves.

As I have before stated in general terms, veratrum viride in these cases of disease of the heart is of special value, not only in the treatment, but also in enabling the physician to arrive at a correct diagnosis. It lessens the irritability of the organ, and thus gives character to the rhythm, and evidently from the volume and regularity that it gives to the pulse, there is a more complete contraction of the chambers of the heart.

Without the use of veratrum viride I could not have made this diagnosis; and although I could not by the knowledge of it restore the integrity of the valves, I could and did for some time, by proper care, prevent an increase of the difficulty.

After the danger of the pneumonia had passed, my first care was to remove him to a light, well-aired room, and as soon as possible put him on the use of hæmatic remedies, with small doses of veratrum viride, and a plain nourishing diet, so as to get the

blood into a healthy condition, and thus prevent the irritability induced by impoverishment.

Not liking a life on shore, he again went to sea. I saw him after his return from two voyages; but during the third voyage he fell dead from the rigging of the ship.

Case 11. A woman aged 65 years had frequently sent for me to relieve her of urgent dispnœa, which was supposed to be asthmatic. The attacks were generally induced by bursts of ill temper, or by fretting. I had used several remedies, but the tincture of veratrum viride gave her more permanent relief, and was at last the only remedy used.

The present attack was caused by grief on receiving news of the death of a child. The dispnœa was painful, the respirations were very frequent, the pulse thready; there was great thirst, and frequent fainting fits. She died before I arrived, as the friends said, of suffocation.

On a post-mortem examination ten hours after death, the lungs, heart, stomach, and kidneys were found perfectly healthy; but on closely examining the lungs to ascertain if there was any change in their structure, caused by the frequent attacks of asthma, I found that the lining membrane of the pulmonary veins was covered in many places with large patches of opaque substance, somewhat redder in color than the lining membrane of the vessel.

These patches were of different size, some of them occupying more than one-half of the calibre of the vessel, others quite small and occupying distinct points.

The larger patches were thicker than the small ones, and on some of them, distinct lamellæ could be peeled off. As though their presence upon the inner coat of the vessels was not impediment enough, their favorite seat seemed to be just beyond where the two vessels united; in this place they were larger and thicker than elsewhere.

This I suppose may be called hypertrophy of the lining membrane of the vessels. It existed to a great extent over both pulmonary veins, and several patches of large size were found in the aorta, the largest just beyond and almost in connection with the aortic valve.

There was no bony deposit in any of them, and I do not know if there would have been bony depositions, if the patient had lived longer.

The color of those in the aorta were more of an opaque grayish-white, while those in the pulmonary veins were reddish and apparently much congested.

The result of the post-mortem fully accounted for the benefit derived from the use of the veratrum viride, in preference to other remedies, as its sedative action tranquillized the circulation, and, as we have seen in the experiments upon frogs and bats, dilated the vessels.

Case 12. L. J., æt. 8 years. I found this child very ill with double pneumonia, the pulse was wiry and too rapid to count. I gave her veratrum in large doses, but it produced but very little effect upon the pulsations or respirations. She was partially unconscious, throwing her arms wildly about her, constantly smacking her lips, and straining as though she wished to swallow something. She remained in this unpromising condition without relief for twenty-four hours, and with no diminution in the frequency of the pulse, although very large doses of veratrum were given. Feeling that there was some cause of irritability in the stomach, I gave her a drachm of sulphate of zinc. She almost immediately vomited a large quantity of yellow, viscid, ropy mucus, and with it *two large worms* (ascaris lumbricöides).

Without the administration of any more veratrum, within one hour from the removal of these worms from the stomach, the pulse was beating 82 in the minute, soft and compressible, *and was reduced at least* 100 *beats in the minute.* The countenance was pale, the skin moist, and the respiration easy.

The child became suddenly alarmed, and screamed, and kicked off the bedclothes. Another large worm, 7¼ inches in length, was found alive in the bed just passed from the anus. From this time the child did well, and in three days was dressed and sitting up.

We have many instances to convince us that the presence of tænia, or lumbricöides will greatly derange the action of the heart; but have we sufficiently noted that they prevent, retard, or interfere with the action of medicine?

DIVISION SECOND.

THERAPEUTIC APPLICATION OF VERATRUM VIRIDE IN TYPHUS AND TYPHOID FEVERS.

It has been frequently asserted by many who have written on this remedy, that it is a *specific* in these fevers, and that with it they could "cut short the fever in from twenty-four to forty-eight hours." We must confess that such persons know its uses better than we do, or else that they are mistaken in their diagnosis, for we have never met with such success.

It is true that with this remedy the heart's pulsations can be controlled, and that so long as its use is persisted in "the fever" is moderated; but as the fever and arterial irritation are but symptoms, and caused by a morbid material within the system, and are not the disease itself, or the cause of the disease, we cannot see how it should by its sedative effect "cut short the disease in from twenty-four to forty-eight hours."

There are few diseases of equal severity wherein the circulation is so little roused to excessive action, as in typhoid fever, the character of the pulse being one of irritability, or at least of asthenic inflammation rather than of active inflammation.

It may, perhaps, seem strange to some that a remedy that is used with such marked success in sthenic diseases should under any circumstances be recommended for diseases of a directly opposite character. But in sthenic diseases it is used in large doses, and its power is promptly spent in controlling the excessive action of the heart and arteries, and its neurotic or nerve action is not so much noticed, because it is secondary in importance; but in asthenic diseases, if judiciously administered in small doses, and kept within proper limits, its nerve action is more perceptible, quieting the irritability of the nervous system, and the irritable state of the circulation, permitting the pulse to become fuller in volume, and more normal in character.

In one disease we have excessive arterial excitement and impetuosity of the heart's movements, and we endeavor to control that violent action, and bring back the pulsations to a normal standard; in the other we have nervous excitement with depression, causing the heart's movements to be irritated, weakened, and quickened, producing a continual slow fever; and by quieting that

nervous excitement we lessen the irritability and prolong the systolic movements; in both cases we seek to bring the heart's pulsations to a normal standard, and by so doing we lower the fever, and by this means alone prolong existence.

The consecutive effects of veratrum viride are, in typhoid fever, of great importance. In this fever the skin is generally dry, the tongue smooth and parched, and the secretions lessened.

Under the judicious use of this remedy the skin becomes moist, the salivary glands secrete freely, the urine is more abundant, the expectoration is easier and more free; and although the bowels are not acted upon by it, the irritability of the intestines is lessened, and therefore there is less necessity for laxatives; and if they are given they are required in smaller doses.

In one respect, I believe this remedy acts in a directly opposite manner to narcotics, for whereas narcotics suspend proper oxidation and elimination, this increases the oxidizing power of the system.

As grave and serious alterations in the structure of the muscular tissues of the heart frequently take place in typhus fever, and as these morbid changes are similar in character to those which result from sthenic congestion and inflammation of the muscluar tissues of this organ, it is exceedingly important that the physician should closely watch the peculiarities of the action of the heart, and devote special attention at each visit to its impulse and intonations.

There are numerous instances in typhus fever where, early in the disease, the heart's action becomes exceedingly feeble, and its sounds denote that the muscular structure of the organ has become enervated, and that the propulsive power is weakened, independently of the insufficiently stimulating character of the blood.

Even the best authorities in these cases have not yet decided that this change is not the result of inflammatory action, and although we know that the stimulating plan of treatment is absolutely necessary, for by its means only can we maintain the proper force of the heart, we find that the irregular, frequent, and true asthenic pulse becomes more regular, less frequent, and of better tone and energy by the proper and careful administration of small doses of veratrum viride.

In many cases of typhoid and typhus fever there *are periods* when this remedy is of very great value, as it steadies the action of the heart by lessening its irritability, insures the complete contraction of its chambers, and thereby gives volume to the pulse

and regularity to its intonations; it also acts favorably by its consecutive eliminative power.

But it is no "specific" for typhoid fever (as Norwood and others assert), "breaking up many cases at the very outset," and "curing others in from 24 to 48 hours." It is to be regretted that any physician should make so irrational an assertion.

In these diseases it should only be administered in small doses, as large ones produce excessive prostration, and thereby injure rather than benefit the patient.

IN PHTHISIS: ALSO AS A MEANS OF DIAGNOSIS IN DISEASES OF THE LUNGS AND HEART.

I will not speak of the therapeutical applications of veratrum viride in consumption, for from the indications already detailed for its use, its value in the general treatment may be readily inferred.

In the *diagnosis* of the meagre and subtle signs, by which this insidious disease first makes known its approaches, I have found veratrum viride to afford me the most essential service, rendering clear and easily recognizable signs which, without the previous preparation of the patient by this remedy, were obscure and of difficult diagnosis.

When the tubercular deposits have made large encroachments upon the lung, and loud mucous rales betray the existence of a cavity, there is no difficulty in making a diagnosis that at this stage must be synonymous with a fatal prognosis.

But without the previous preparation of the patient, by this remedy, the prolonged expiration, faint crepitation, or slight harshness of respiration, the frequent complications of functional disturbance of the heart, the extent to which its sounds may be heard and its murmurs mask the true signs from the lungs, or other causes tending to obscure the respiratory murmurs, exercise a most perplexing influence, and prevent or render difficult a clear diagnosis at precisely that stage, when treatment may reasonably be expected to be of some avail. It is these early signs that are likely to escape detection, to be overlooked or rendered obscure, and great caution needs to be exercised to discriminate between functional disturbance and organic lesions.

To properly discriminate these differences, I have, for several years, been in the habit of preparing my patient, whose heart or lungs I wished to examine, by the administration of small but frequently repeated doses of veratrum viride, and have thus been

enabled to easily attain a *certain* knowledge of the signs of the disease at an early period, when, without this preparation, a correct diagnosis could be arrived at *only* with great trouble and most patient investigation.

It will be found of inestimable advantage in the diagnosis frequently required by *Life Insurance Companies.* I have before mentioned it as a means of diagnosis in pneumonia and valvular disease of the heart. (See Cases 2, 5, 10.)

DIVISION THIRD.

THERAPEUTIC APPLICATION OF THE RESINOID OF VERATRUM VIRIDE.

Case 1. Surgical Fever. J. B., æt. 34 years. A stout muscular mechanic, upon whom a surgical operation had been performed for the removal of a large tumor. As reaction came on he became exceedingly uncomfortable, with all the symptoms of surgical fever.

The fever commenced soon after my morning visit, and as I was not informed of it, I did not see him again till the next morning.

The pulse was then 165, and the respirations 30. I commenced the use of the resinoid tincture of veratrum viride alone.

Date.	Pulse.	Respirations.	Treatment.
June 19th, 10 A. M.	165	30	Resin. tr. ver. vir. ♏v.
11 "	160	30	" " ♏iv.
12 "	162	30	" " ♏v.
1 P. M.	147	29	" " ♏iij.
2 "	138	26	" " ♏iij.
3 "	125	25	" " ♏iv.
4 "	97	24	" " ♏iij.
5 "	95	25	" " ♏iv.
6 "	79	20	" " ♏iij.
7 "	71	20	" " ♏iij.
9 "	64	20	" " ♏iij.
11 "	65	20	" " ♏iij.
20th, 1 A. M.	64	20	" " ♏iij.
5 "	76	20	" " ♏v.
8 "	72	20	" " ♏v.
10 "	63	20	" " ♏iij.
12 "	64	21	" " ♏iv.
4 P. M.	68	20	" " ♏iv.
7 "	64	20	" " ♏iij.

From this time he was left in charge of his friends, with directions to give him four minims of the resinoid tincture every four hours; this treatment was continued for three days longer, during which time the pulse did not rise above 75 in the minute. There were no unpleasant symptoms afterwards.

Case 2. Pleuritis. Mrs. N. R. When I first saw this patient, she had acute pleurisy of the left side.

Time.	Pulse.	Treatment.
11 A.M.	132	Resin. tr. ver. vir ♏v.
12 "	130	" " ♏v.
1 P.M.	121	" " ♏v.
2 "	120	" " ♏iv.
3 "	98	" " ♏iv.
4 "	96	" " ♏iv.
5 "	92	" " ♏v.
6 "	72	
7 "	60	" " ♏ij.
8 "	54	

At 8½ o'clock she attempted to get out of bed, but the moment she rose up she was seized with nausea, and fainted. Upon recovering from the fainting fit she vomited twice, and then lay back in bed in a quiet dreamy state. At 11 o'clock the pulse had risen to 62.

Three minims of the resin tincture were continued every two hours until 7 P.M. of the next day, when she was entirely well and free from pain.

Case 3. Acute Bronchitis. I was called to see a young man æt. 22, suffering with extreme dyspnœa. He was propped up in bed, and endeavoring to gain some relief by breathing the vapor from a pitcher of boiling water. The efforts at respiration were painful to witness, and the expression of the face and the position assumed were indicative of extreme suffering. He could speak but a few words at a time, but begged me earnestly to give him quick relief, or he should die of suffocation.

Upon percussion I found the chest resonant, but upon listening I could hear no vesicular respiration; the air entered the lungs slowly, and seemed to leave them more slowly and with effort, causing a harsh sibilant sound. There was much fever, with a small, frequent, irritative pulse, which could not be counted.

I gave five minims of the resin tincture of veratrum viride, and repeated the dose every hour until four doses had been given. Before the third dose had been given, the pulse could be counted 138 in the minute, and after the administration of the fourth dose it was 129.

The same dose was continued at intervals of two hours, and the respirations gradually became fuller and less labored. He could

not lie down, but slept considerably while propped up in bed during the night. The same dose was continued at intervals of two and a half hours through the next day with very marked relief, so that he could with high pillows lie down comfortably. This dose kept the pulse at between 80 and 90 beats, but produced no vomiting.

On the evening of this day slight crepitation could be heard in many spots, and the next day crepitation could be heard over the whole lungs, and there was slight expectoration.

The remedy was continued at longer intervals, and on the eighth day he was out attending to business.

Veratrum viride is, probably, more serviceable in cases of acute bronchitis than in any other disease. In nearly all instances it entirely supersedes the necessity for venesection, in fact, it relieves the physician from all necessity for discussing the propriety of venesection.

Its first effect alone, of lessening the rapidity of the circulation, does all in this inflammation of the mucous surfaces that could be effected by venesection, for by diminishing the quantity of blood sent to the lungs, arterialization can more fully take place, and the painful sense of suffocation is thereby relieved.

As a sedative it relieves the painful dyspnœa, and as an expectorant it removes the consequences of the inflammation. Venesection produces debility, which, at times, in this disease cannot be recovered from, whereas veratrum viride produces no debility.

Case 4. Delirium Tremens. During the last seven years, I have recorded in my note-book the results of the treatment of many cases of delirium tremens with veratrum viride. In thirteen cases of this disease the treatment was with resin tincture of veratrum viride alone. I have succeeded well with this treatment, and of these thirteen cases not one proved fatal.

The plan of treatment has usually been to give four, five, or six minims every hour until the pulse was reduced to 60 or 70 beats in the minute, and until nausea was induced; then a smaller dose was continued at longer intervals. These are always troublesome cases that require frequent personal attention.

In some of these cases the same treatment has been adopted until nausea and vomiting have been induced, then morphia in $\frac{1}{4}$ gr. doses has been administered as often as found necessary, and have

produced a better effect than a grain of morphia would do without the previous preparation by veratrum.

The veratrum is usually continued for several days in small doses. In two cases recorded it was continued for ten days after the delirium had ceased. It relieved the irritable state of the mucous membrane of the stomach, and restored the appetite.

I have frequently relieved the uncomfortable feeling following a debauch by small and frequent doses of veratrum viride and bicarbonate of potassa.

I have found the resinoid tincture of veratrum viride of more service than any other medicinal preparation in producing that perfect relaxation so necessary in taxis for hernia, and in the passage of a catheter for stricture.

DIVISION FOURTH.

GENERAL SYNOPSIS OF THE ALKALOID VERATRIA FROM VERATRUM VIRIDE.

By reference to the second section of this monograph, it will be seen that the alkaloid veratria, obtained from veratrum viride, is identical in its chemical reactions to that obtained from veratrum album, and from veratrum sabadilla.

By reference to the third division of the third section it will be seen that the physiological and therapeutic actions of the various alkaloids are very similar.

In what particular principle of the plant, then, resides the difference in the therapeutic action of the several species of this genus?

We see, from the written history of veratrum album, for many centuries, that it differs in its physiological and therapeutic actions from veratrum viride.

We observe from the few cases reported in the last division[1] that the resinoid principle of the plant possesses nearly the same physiological and therapeutical action as the *whole* plant, and that, therefore, the medicinal action of the plant is due more to the several resinoid principles, which exist in considerable quantities, than to the alkaloid, which exists in a very small quantity.

If the amount of alkaloid alone, which we obtain from a given quantity of the tincture, was dissolved in an equal amount of men-

[1] A very large number of cases might have been added to this division, but I feared that by giving more I should make the work prolix.

struum to which it exists in the tincture, we should find that the small dose administered would produce no noticeable impression.

It is probable, however, that all alkaloids exist, in a natural combination, in larger proportions than we obtain them by chemical means; but if this one existed in double the quantity obtained by isolation, it would still be insufficient, in the small doses that are given, to produce the effects that are noticed by proper medicinal doses.

We have in other medicinal agents alkaloids, which, when in combination with the whole medicinal virtues of the plant, exercise but little influence, but when isolated and given in full doses differ from the action of the entire virtues of the plant.

Aconitina and codeia may be mentioned as examples. We see as much difference in action between veratrum and veratria. When given in doses sufficient to produce a noticeable effect, it does, to some extent, act as a direct sedative to the heart, but it does not act uniformly in this manner, as the tincture of the root or the resinoid does; it has a more mixed action upon the heart—an action somewhat resembling the effect of aconitina, and this is frequently an irritant action, and is more plainly noticed if given in large doses.

The pulse, by full doses of veratria, is first depressed, but afterward the irritant action follows and the pulse increases in frequency, and this, as we have seen in the cases mentioned, is not the action of the tincture of the plant, nor the resinoid.

The question then seems to be settled, that the alkaloid is not essential to the complete sedative action of the plant, and that the resinoid principle, entirely freed from the alkaloid, is equally reliable, as an arterial sedative, as the tincture made directly from the root.

Of the external uses of the alkaloid I do not feel that I have sufficiently elaborated it to speak at present.

I have used it many times, but prefer the alcoholic extract of the plant mixed with glycerine. I have not, with either, met with the same success that Turnbull relates.

SECTION FIFTH.

SUMMARY OF THE PHYSIOLOGICAL AND THERAPEUTIC ACTION OF VERATRUM VIRIDE ON MAN.

DIVISION FIRST.

GENERAL ACTION.

The following observations are given as the results of a very large number of experiments and therapeutical applications, but it is unnecessary to relate these in detail, as I have done in giving my experiments on animals, and in cases of various diseases in the human subject.

The true therapeutic properties of veratrum viride were not understood before Professor Tully's investigations, and Dr. Osgood's publication; nearly all who wrote on it before that time classed it with its European congener, and used it chiefly in chronic complaints.

Dr. Osgood pointed out a class of diseases in which it seemed to produce the same general effects as the veratrum album, but with more certainty and greater safety; but he demonstrated also that, though it was alike in some of its effects, it differed very materially in others.

One of the characteristic effects of veratrum album is the uncontrollable purging it frequently produces if given in full doses, causing whitish, frothy, abundant, and frequently bloody evacuations, which leave the alvine canal in an irritable condition. On the contrary, veratrum viride produces no purgative effects when given in medicinal doses by the mouth.

Dr. John Ware, of Boston, administered it in thirty cases, and in not one was it clear that purging was produced. Such is the testimony also of Osgood, Norwood, Frost, and many others who have used it freely. I have carefully watched over one thousand cases for this effect, and I have never seen a case in which I was satisfied that purging was produced by this alone, when given by the mouth,

but I have seen several cases of constipation depending upon an inflamed or irritable condition of the intestines, relieved by it in somewhat the same way that sedatives or opium will relieve these cases. I have frequently used it in inflammatory states of the system, as an adjunct to a purgative, to overcome the irritability of the muscular fibre of the intestines, and to quiet arterial excitement.

In this way it assists purgative medicines, and causes their more rapid action. It was in this way that it was used in the old secret remedy called "Coit's pills."

The peculiar and characteristic effect of veratrum viride is its action upon the pulse. It is a reliable and powerful arterial sedative. With it the force and frequency of the pulse can be controlled almost at will.

I have frequently found the pulse that was too fast to count—irritable and thready—reduced in the course of a few hours, by moderate doses, to 70 beats in the minute, and by larger and more frequently repeated doses to 40 or 35 beats in the minute, and that with no danger to the patient, for when the remedy was discontinued, the pulse gradually regained its healthy beat, provided the remedy had been used long enough to subdue the inflammation.

It lessens both vascular and nervous action, and at the same time relaxes the muscular system, and renders the respirations easier and somewhat slower. It is particularly applicable where there is a great excess of arterial and nervous excitement on account of some sudden or acute disorder without any great depression of the vital powers, in sthenic inflammations generally, and surgical fevers, and especially those that are sudden and quick in their course, and require to be arrested promptly and quickly.

It is, if possible, more serviceable to the surgeon than to the physician, for in those cases of surgical or traumatic fever, resulting from operations or injuries, its specific effect in arresting arterial and nervous excitement is particularly required, and its effects in quieting and reducing the pulse, and keeping it at or below the healthy standard, until the cause of the excitement subsides, or is removed, frequently prevents serious results.

After operations upon the arteries for aneurisms or other diseases, the action of the heart can be lessened or controlled, and by this means secondary hemorrhage may be prevented. Too great vascular excitement, and a derangement of the circulation, resulting from the obliteration of large arteries, frequently supervenes after operations, preventing a healthy restorative process from going on.

Any means which will control this excitement without the necessity of bleeding (which generally weakens the patient, and thus retards recovery) will assist in the recovery by subduing irritation, and by allowing the system gradually to regain its energies, and accommodate itself to its new relations.

This remedy, in these instances, produces but a transient effect, but may prevent lasting injuries, and prove of permanent benefit by relieving temporary exigencies.

It is also an invaluable assistant in the diagnosis of cases of disease of the heart or lungs.

In a great many instances in which this medicine is indicated, but one simple rule is necessary in its administration, viz: *increase or diminish the dose according to the state of the pulse.*

If it is necessary at the outset of a disease to reduce the pulse from 150 to 60 beats in the minute, and keep it at that number for several hours, give the remedy in as full doses as the patient will bear without disturbance to the stomach, and repeat it at short intervals until the object is attained; the dose can then be given at intervals of three or four hours, according to the state of the pulse.

There are instances in which a prompt arterial sedative is required, and in which vomiting will do no injury; in such cases it may be given in full doses of three or four minims, and at intervals of half an hour, until vomiting is induced; the pulse will frequently, in such instances, sink lower than required, occasionally as low as 50, 40, or 30 beats in the minute: this need occasion no alarm, for it is only necessary to suspend the use of the remedy for some time, and not begin its use again until the pulse returns to the point at which it is intended to keep it. To obviate any unpleasant effects, the medicine may then be resumed in small doses, and repeated at longer or shorter intervals, according to the influence it exerts upon the pulse.

If it is desirable to induce vomiting, let warm diluents accompany the remedy, but should it be necessary to avoid it, give the patient no more fluid than is absolutely required, and administer the medicine in small and frequent doses, carefully watching the pulse. But do not be deceived in the state of the pulse; recollect that position will have a great influence, and if the pulse be found at 60 while recumbent, it will be found at 65 or 70 a few minutes afterwards, if the patient should be in a sitting position, and in a

standing position at 75; and for a short time after the change of position the pulse will have a different character.

In the recumbent position the force of the pulse is always greatest, and the frequency the least, so that we have the greatest strength and the least frequency at the same time. Faintness may be induced if the pulse is reduced too much while in a recumbent posture, and the patient be allowed suddenly to stand up; in fact while under the influence of this medicine the patient should not be permitted to change his position suddenly. Let then the position be the same at the different times of examining the pulse, or make due allowance for the change.

Even in health sleep has a marked influence upon the pulse, and during the administration of this medicine, sleep produces a great change. I have found the pulse to fall 20 beats in the minute within a quarter of an hour, merely from the patient falling asleep. In such cases the respirations become slower and full, the pulse loses its irritability, becoming soft, full, and easily compressible; the secretion from the skin is very abundant, becoming cold and clammy if there has been much nausea or prostration.

In this state there will be no difficulty in arousing the patient, as there is when narcotics have been administered.

DIVISION SECOND.

ITS ACTION ON THE VASCULAR SYSTEM.

Veratrum viride exerts a *sedative* influence upon the vascular system. In whatever medicinal doses it is administered it regulates the force and frequency of the pulse. Whether it is given to the chlorotic female, with a pulse of 120, thin, wiry, and irritable, or to the threatened apoplectic, with a full and bounding pulse, or in fatty degeneration of the heart, where the pulse is slow, easily compressible, wanting in tone, it alike regulates the force and frequency of the pulse, and exerts a sedative influence on the heart's action, bringing it by proper doses to the normal and healthy standard.

If the dose administered be small and frequently repeated, the pulse may be reduced from 120 to 80 beats in the minute; if a larger dose be given it may be reduced to 50, but it does not become irregular or intermittent, unless the remedy is pushed beyond the point of propriety.

In poisonous doses the pulse loses its rhythm and strength, becoming very slow and compressible, sometimes allowing an intermission of several seconds to pass. It is unlike aconite in its effects, for, to a certain point, aconite reduces the irritability and frequency of the pulse; but if the dose be pushed beyond this point, the pulse becomes small and weak, but more frequent. I have several times seen the pulse quickly increased from 80 to 120 by an increased quantity of aconite; but I have never seen the same effects from veratrum viride.

With most other remedies, when the heart's pulsations have decreased in intensity, there seems to be an effort at compensation, and they cause an increase in frequency of its pulsations. This is not the case with veratrum viride in medicinal doses, for the heart seems unable to acquire intensity, and is too thoroughly subdued to attempt the compensative effort of frequency. As it decreases in frequency it increases in fulness and regularity, and we find that the patient does not lose strength, but gains tranquillity.

In poisoning by this agent there is a labored effort of the heart; the pulsations are sometimes increased in frequency, and are intermittent, and found to vary every few minutes.

Whether in all primary inflammations it is a mere reduction of the frequency of the circulation and of nervous excitement that is needed, or an actual change in the character of the blood as well, it is not my province to discuss at this time, but every one's experience must give him some evidence on this point.

We have seen and shall find hereafter in the experiments performed for this purpose, that this medicine exerts an action on the blood, and that action is of an antiphlogistic character, because it alters the blood by elimination; but does it act as some of the saline medicines do as a solvent of fibrin, either while within the veins or out of the body?

It has been demonstrated by Simon, and confirmed by Bird and others, that tartarized antimony and many of the salines have the power of diminishing the amount of fibrin in the blood, and by this means relieve the tendency to inflammation. Veratrum viride has not the power of dissolving fibrin when out of the body, nor does it produce the effects of antimony and salines upon the blood within the veins, by diminishing its plasticity and rendering it liquid and incoagulable.

Its action is principally a vascular sedative, producing, as we shall see, a change in the blood itself, and a peculiar effect upon

the heart, arteries, and veins. I have taken a small quantity of blood from a person of full habit, laboring under a mild attack of pneumonia, and who had been for twenty-four hours fully and decidedly under the influence of veratrum viride, with a pulse at 50. The blood coagulated and had a tolerably healthy appearance.

This would not be conclusive proof, because in diseases of an inflammatory character the amount of fibrin in the blood is increased; I repeated this experiment, therefore, upon dogs in health, the results of which may be seen in Experiments XXIII., XXIV.

In the 4th Section of this work we have given many instances of the therapeutic uses of the plant; but we have also given instances where it was of inestimable value as a means of diagnosis, and where organic lesions of the vascular system were readily detected while the patient was under the influence of the medicine, that could not be definitely diagnosed, or at least, could be discriminated only with great difficulty from functional disturbances without preparing the patient by this remedy.

By the assistance of veratrum viride we have in many instances been enabled with ease definitely to determine between organic and functional disturbance of the heart. There are instances in which it would be of value as a means of diagnosis in aneurisms. Though this is the best, I do not claim that it is the only sedative that can be used for its diagnostic properties; digitalis, tartarized antimony, and others may be used, but I am not aware that any of these remedies were resorted to for such purposes previous to my recommendation.

DIVISION THIRD.

ITS ACTION ON THE RESPIRATORY SYSTEM.

The action of veratrum viride on the respiratory system is secondary to that on the vascular and nervous system. It reduces the frequency of the respirations somewhat in proportion to the effect it has upon the circulation, and not always in proportion to the dose administered.

Where the circulation has been very rapid, and the respirations consequently frequent, we find that as the circulation becomes more normal, the respirations decrease in frequency; but, unlike opium, this remedy does not reduce the respirations much below

the normal standard. Its effect is *sedative*, not narcotic, on the respiratory nerves. Thus it is expectorant, increasing the secretion from the pulmonary mucous membrane; first, by its action upon the blood and bloodvessels; and secondly, by lessening or subduing irritability of the lungs.

Owing to the diminished circulation and respiration, the temperature of the body is decreased while under the full influence of the veratrum.

As a means of *diagnosis* in *pneumonia*, *bronchitis*, *pleuritis*, and in *incipient phthisis*, I have spoken fully in Section Fourth.

DIVISION FOURTH.

ITS ACTION ON THE NERVOUS SYSTEM.

Veratrum viride exerts a sedative effect upon the nervous system, but whether it produces its primary effect upon the vascular or the nervous system, we will consider when we discuss its modus operandi.

In medicinal doses it simply allays, controls or deranges nervous influences, but in poisoning doses it destroys them.

Though it seems to exert but little action upon the *mind*, it makes the individual languid, quiet, disposed to sleep, and unwilling to be disturbed; and this effect is marked where it has been given in small and frequently repeated doses, controlling the heart's action, without producing nausea and vomiting; but it is most noticeable where it has been taken in large and poisonous doses.

These effects succeed its emetic action. Even in these cases the mind is clear, or but little confused; and although by diminishing the rapidity of the supply of blood to the brain, it produces vertigo, especially on moving, it seldom causes headache. In full doses it undoubtedly diminishes sensibility, but I have never noticed any marked impairment of either sight or hearing when administered to man. In animals I have noticed both.

Its effects upon the brain temporarily resemble those produced by loss of blood, and they are undoubtedly produced by the sedative action on the circulation. Under the full influence of the medicine a change of position will produce vertigo or even syncope. It frequently induces sleep; not by any narcotic action, but by elieving congestion, irritability, and pain.

DIVISION FIFTH.

ITS ACTION ON THE MUSCULAR SYSTEM.

In moderate doses veratrum viride produces a relaxation of the muscles, and in fuller doses, a feeling of weakness and prostration. This effect soon passes off, and with a return of the normal circulation there is a return of muscular strength; it produces prostration rather than exhaustion.

We have before stated, when treating of its physiological action on animals, that in full doses it paralyzes both the voluntary and involuntary muscles, and in those cases where death is caused by it, the fatal result is produced by paralysis of the heart's action. One of the most remarkable effects of its action, in poisoning doses, is that the muscles have so lost their contractile power that they do not act well under the stimulus of galvanism.

This loss of power of the muscular system, and its subsequent results upon animals poisoned by veratrum, I noticed some years ago. During a series of investigations upon veratria, obtained from veratrum album, and from veratrum viride, I noticed that animals poisoned with the alkaloid from either plant lost all power over the locomotive muscles, and that the galvanic current did not exercise the same convulsive movements after death from this as it did in cases where death was produced from other causes.

It has been asserted that this remedy always causes dilatation of the pupils. Such is not my experience; it does sometimes dilate, but generally it merely fixes the pupil, giving it the appearance of dilatation because it is kept in the centre, without motion, owing to the loss of power in the recti muscles.

DIVISION SIXTH.

ITS ACTION ON THE SECERNING SYSTEM.

Veratrum viride exerts a very marked influence on the secreting organs. It augments the secretion from the pulmonary mucous membrane, and increases the expectoration in the first, second, and even third degree of its operation, but in the fourth degree there is no longer power to expectorate, so that the increased secretion is an additional source of danger.

Upon the urinary secretion I have not been able to satisfy myself that, in health, it either diminishes or augments the quantity. As the amount of the secretion differs so greatly at different times, and under different circumstances, a long series of close observations would be necessary to decide upon its effects.

In cases of dropsies, resulting from obstructed portal or cardiac circulation, with a frequent and irritable pulse, there is no article in the materia medica that produces so copious a discharge of urine. But this is a mere secondary effect, caused by subduing the heart's labored action. As the congestion is lessened, the kidneys carry off the excess of serum, and absorption of that already deposited takes place. In most cases of disease it increases the specific gravity of the urine. (See Cases 2 and 5.)

But the chief secerning effect of veratrum viride is upon the skin. In whatever doses it is taken its effects are plainly manifest. In small doses it produces a pleasant comfortable moisture, but in large doses the diaphoresis is free and abundant, the perspiration standing in large drops upon the brow and face. If full doses of the remedy are given, and the person is warmly covered, the diaphoresis is free, and the skin feels moist and comfortable, but any portion of the skin which is left uncovered is bathed in a cold, abundant, clammy sweat. And herein is one of its most valuable uses, for in some cases of fever, where the skin is harsh and dry, a favorable crisis may be produced by causing an abundant diaphoresis.

It early acts as a sialagogue, freely increasing the secretion of saliva. It should not be forgotten that amongst the functions of the salivary glands the rapid and copious elimination of fluid that takes place, especially if abnormally excited, does much towards relieving the congested state of the vessels; and its secondary effects, in promoting the absorption going on in the stomach, assists the ultimate removal of a large quantity of fluid by the kidneys.

By these effects, as well as its effects upon the circulation, veratrum viride is a true antiphlogistic. By its rapid eliminative action on the glandular system, it causes absorption and disappearance of glandular enlargements.

I have discovered traces of its active principle in the urine, but I do not, on that account, conceive it to be diuretic, but that its diuretic effect is owing to diminished pressure upon the vascular system. Digitalis acts as a diuretic in the same way.

When the alkaloid veratria was administered to dogs, either by hypodermic injection or by the stomach, the alkaloid was several

times detected in the urine, and the urine produced also the same physiological results when administered to other animals. (See Experiments IX., X., XI.)

It was also detected in the milk of a nursing woman (see Case No. 6), and under the use of the medicine the inflammation subsided. Induration of the lymphatic glands is also relieved by it.

DIVISION SEVENTH.

ITS ACTION ON THE ALIMENTARY CANAL.

Veratrum viride increases the secretion of mucus from the stomach and intestines, and by its nauseating effects produces a continuous sympathetic action on the liver and pancreas. It has no cathartic nor aperient effect upon the bowels when taken by the mouth; but as it lessens congestion and irritability, constipation is frequently relieved by its use.

When injected into the cellular tissue we see that it does act as a cathartic (see Expts. IV. and V. of Div. 2d). In plethoric constitutions it forms an admirable adjunct to purgatives. The veratrum album, on the other hand, does act as a purgative when taken by the mouth as well as when injected into a vein or the cellular tissue.

DIVISION EIGHTH.

EMETIC ACTION.

In full doses, 10 to 15 minims of the concentrated tincture, before described, it produces vomiting, and by the first act of vomiting the contents of the stomach are sometimes thrown off without much preceding nausea, the stomach alone seeming to contract upon its contents, and the abdominal muscles and diaphragm remaining comparatively passive.

But the vomiting most usually produced by veratrum viride is preceded by nausea, prostration, a marked diminution in the frequency of the pulse, and paleness of the face and lips.

If vomiting from the use of this agent continues long, it frequently becomes spasmodic, and much bile is thrown off, owing to the extension of reflex action to the duodenum and liver; and when bile is thrown off there is more protracted vomiting, more painful nausea, and general prostration.

If the dose be large its effects as an emetic will be certain, strong,

and permanent, and will make a powerful impression on the system. As an emetic it should be used only in those cases where the pulse is strong and full, or where there is phlogistic action; it would be unwise to administer it for its emetic effect where the patient was feeble or deficient in either nervous or vital force. Above all, it should not be given for *its emetic effect* where there is a natural liability to syncope, or where there is disease of the heart.

If the remedy be given in overdoses, the effects described by Osgood are, vomiting, followed by "much ineffectual retching, almost constant hiccough, chilliness, dimness of sight, vertigo, inability to control the voluntary muscles, distress of the stomach, pulse small and creeping." I have seen all these effects from accidental poisoning with this article, but I have never seen such effects when administered in medicinal doses.

If it be necessary to avoid vomiting, and the stomach is sour and irritable, give a little bicarbonate of soda, magnesia, or other alkali; it is necessary to lay much stress upon this, for if the stomach be in an irritable condition, the veratrum will act too harshly, unless checked by the previous administration of the alkali.

When it is necessary to give the remedy as freely as the patient will bear it, to produce its sedative effect upon the circulation and upon the nervous system, it is well never to omit to learn the condition of the stomach, and if there is gastric irritation it should be controlled by soda and hyoscyamus, or morphia, that emesis may not be produced.

Although its emetic effects are exceedingly valuable in controlling acute inflammations, such as ophthalmia, gonorrhœa, and croup, and severe nervous affections, or fevers of a high grade, it is not the depressing effects of nausea which cause the reduction of the force of the circulation; for I have with this agent reduced the pulse to 30 beats in the minute, without causing the slightest nausea; and we almost always see a reduction in the number as well as the character of the pulsations before nausea is induced, and especially where it is given in full doses for the purpose of producing vomiting. And vomiting frequently takes place without any precursory feelings of nausea, but not before the effects of the medicine are plainly felt upon the pulse.

It seldom acts as an emetic except in very large doses, in less than three-quarters of an hour, and sometimes not before one or two hours, but its effects upon the pulse are sometimes distinctly felt in fifteen minutes after its administration, and they are thus

early noticed not so much in the reduction of the frequency of the pulsations as in the greater softness of the beat, and the lessening of its nervous, irritative character. This will be apparent by referring to those cases previously reported, in which the medicine was administered by injection into the veins.

When the stomach has once been emptied of its contents by an emetic dose of veratrum, the fluid that is afterward vomited is peculiar, and unlike other fluid that is thrown up from the effects of any other medicine with which I am acquainted. It is a viscid, ropy, semifluid mass, having much the appearance of the white of egg mixed with a portion of the yelk, but not so deep in color as if the whole of the yelk had been mixed with the albumen. Occasionally the vomited matter is an opaque yellow, but it is generally transparent; sometimes it looks exactly like egg in a state of decomposition. It has the same peculiarity, whether vomited by human beings or dogs or cats.

Objections have been raised by some persons as to the pure *sedative* character of this medicine, because it produces an emetic action. The objection is not tenable, as other sedatives, as tartar emetic, produce a like effect, and nearly all derange the action of the vagus nerve.

Norwood is in error when he says "it is a certain and valuable emetic;" it is certainly a powerful and alarming one.

DIVISION NINTH.

RECAPITULATION. FIRST, SECOND, THIRD, AND FOURTH DEGREES OF OPERATION.

First Degree of Operation.—If two minims of the concentrated tincture are administered to an adult; its effects are scarcely perceptible in any way for less than an hour; its effects will then be noticed by a diminution in the force of the pulse, which will gradually become softer. No symptoms that are perceptible to the patient will be felt from one small dose; but if the same dose be repeated an hour after the administration of the first, and so continued for three or four consecutive hours, there will be a marked diminution in the frequency of the pulse, together with diaphoresis and increased flow of saliva. Doses of this quantity administered hourly for four or five hours, will frequently cause the pulse to fall from 150 to 90 or 80 beats in the minute, and the respirations will become fuller and less frequent.

Second Degree of Operation.—If a dose of five minims of concentrated tincture be given every hour, vomiting will generally be produced before the fourth hour, and frequently before the third. The first vomiting is usually very easy; sometimes not preceded by nausea, and sometimes the nausea occurring only a few minutes before vomiting. At other times the nausea is felt early, and is persistent for several hours before vomiting takes place.

The pulse by the third or fourth hour will frequently be reduced to 60 beats in the minute; and if the remedy is now continued in diminished doses, at rather longer intervals, the pulse may be kept at this state as long as desired.

The patient continues to express a feeling of nausea if he attempts to sit up; but if left undisturbed, is easy, drowsy, and inclined to sleep, or at any rate to rest quietly. The mind is clear, but slow to take notice.

The skin is covered with a clammy moisture upon parts of the body that are exposed, but if covered, the feeling is that of moisture, with a comfortable but lessened degree of heat of the skin.

The secretion of saliva is free, sometimes viscid, with an increased secretion of bronchial mucus. The urine is augmented if there has been any preceding fever.

Third Degree of Operation.—If the same dose of five minims is continued after vomiting at the same intervals, or if a large quantity is given too freely before vomiting, the pulse will be reduced to 50 or 40 beats in the minute.

The nausea will continue with an occasional eructation of a mouthful of viscid mucus, and if the remedy is not suspended there will be much retching and painful vomiting, with præcordial distress. The countenance will become pale, and the aspect alarming to the friends.

If the patient assumes an erect position he will become faint. There is great muscular relaxation and feebleness, and sometimes dimness of vision. The respirations become uneasy and irregular. The surface of the body is wet, and where exposed quite cool. The mind is not disturbed, and the patient, if not frightened by the friends, will feel no alarm.

If the remedy be suspended these symptoms will subside in three or four hours, and will entirely pass over in six hours.

This state will occasionally be caused by exceedingly small doses in those who are very susceptible to its influence.

Fourth Degree of Operation.—Where large doses have been given

by mistake, or where too large ones have been given at frequent intervals, and continued too long, there will be violent and continued vomiting and retching, the countenance will become exceedingly pale and ghastly, the prostration will be great, and syncope will occur if the head is raised much above the horizontal position.

The feelings are more those of prostration than pain; but sometimes there is great præcordial distress. Sensation and consciousness remain, but are impaired, and there is depression of the mental power; the patient hears what is said, but is unwilling to answer questions, or to be disturbed in any way. Muscular action is impaired, and the vision is dim. The voice is weak and the respirations slow.

The pulsations are unfrequent, and sometimes irregular and intermittent, reduced to 30 beats in the minute, and in one instance related to me, to even 19 in the minute. The surface is cold, and bathed in a profuse clammy sweat.

Patients, even in this state, recover more rapidly than would be supposed, if the proper remedies are administered, as it is a state of prostration, not of exhaustion.

I have never seen nor heard of the death of a human being from veratrum viride; its poisonous effects on animals are described under their proper head.

Many physicians have employed veratrum viride in moderate doses, and yet have produced the effects here described as resulting from its excessive use.

The friends of the patient, greatly alarmed, have summoned the physician in haste, and unless he has seen such cases before, or is aware of the effects occasionally produced by this remedy, he is equally alarmed.

I have heard of many such cases, and the physician has afterwards forsworn the use of the medicine, considering it one of extreme danger. This result will seldom happen, if it is given in small doses, and frequently repeated, watching the character and frequency of the pulse the while, and suspending or reducing the dose when necessary. But when it is given in full doses, and at longer intervals, and the character of the pulse not closely watched, the result before described will be produced.

Although it has no cumulative effect, the first few doses sometimes produce but little action, owing to a derangement of the stomach, or want of assimilation, but when absorption does once commence, the whole is taken up at once, and produces alarming effects.

It certainly is not a mark of wisdom to discard the use of a remedy, which has been proved to have such peculiar powers, simply, because in a few cases, which have been improperly watched, it has produced more serious effects than were either desired or expected. All remedial agents might be discarded on the same grounds. Such accidents should serve as lessons, and prove both the power and utility of the remedy, and the necessity of carefully watching every symptom of the patient.

DIVISION TENTH.

VERATRUM VIRIDE IN LARGE OR POISONOUS DOSES.

There are several instances on record where veratrum viride has been taken in very large doses,[1] two fluidounces and over of

[1] *Is Veratrum Viride a Poison?*—We see in the May number of the Chicago *Medical Examiner* "A case of poisoning and recovery from the use of Veratrum viride, by N. O. Pearson, M. D."

We should hardly notice this isolated case were it not that many similar cases have been before reported, and in consequence some persons feel afraid to use the article in question. It will be noticed in this case that the patient took nearly seven minims of the tincture of veratrum every half hour until he had taken three doses in all, amounting to about twenty minims in 1½ hour. The usual symptoms of vomiting and prostration followed, with a pulse reduced to twenty-four in the minute, "full and intermitting every sixth or seventh beat." The physician was alarmed, and administered opium in a "most prodigal manner," and his patient recovered. He says, "This was a case of poisoning by veratrum viride, and should teach us to be very cautious in the use of so powerful a remedy." We should undoubtedly be cautious in the use of every remedy, and should not administer it in its full dose until we are most perfectly acquainted with its powers. We certainly differ in opinion with the author of this reported case; and we feel perfectly assured that if he continues to administer his remedy as he recommends —"until it produces a livid hue of the cheeks"—he will have many opportunities to cause himself and his patients more alarm than in the present instance. This "livid hue of the cheeks," of which he speaks, is but one of the symptoms of the full effects of the remedy, and indicates that it has been pushed to the point of prostration; and no one will pretend for a moment to assert that it needs in all cases, or in a majority of cases in which its use is indicated, to be pushed to that extent. That point of producing "a livid hue to the cheeks" is very seldom reached until vomiting is induced, or the usual nausea and paleness preceding vomiting, and in nine cases out of ten in which veratrum is indicated, we do not wish, in fact we wish to avoid vomiting.

We think our friend has erred in the deductions he has drawn, and as he gets better acquainted with the therapeutic effects of his remedy, he will himself acknowledge so. Had he not administered opium, his patient would have recovered quite as well, as every one who has used the veratrum to any extent will assure him. We have several times induced just such a state, and purposely kept our

the concentrated tincture, but I have never met with a death from its action, nor have I ever seen a single authenticated case on record where death ensued from its use.

Those cases, in which large doses have been taken, that have come under my observation, have been alarming from the excessive prostration produced; but they have been relieved by stimulating remedies, and within twenty-four hours the effects of the medicine have passed over.

As a large dose taken at one time causes quick, free, and frequent vomiting, a great portion of it is necessarily ejected from the stomach, but a small dose frequently repeated is absorbed, and although it produces vomiting and retching, the prostration produced is

patient at that point for the purpose of overcoming his disease, nor have we felt the least alarmed; but it is not frequently necessary to administer it in such doses. But in all cases where it is necessary to induce such a state, we carefully and *frequently* watch the pulse, and are guided in our doses by its action.

But our principal object in bringing these cases before the notice of the profession is to elicit information, and we would ask, to what extent is veratrum viride a poison? And if it produces death, in what manner does it do so? It is not our intention at present to write a treatise on veratrum viride; that we will leave till a future number, but we will give some few interesting cases, to show to what extent it has been taken.

In the year 1823, a farmer of our acquaintance procured ten pounds of swamp hellebore, and boiled it in water down to a gallon of fluid for the purpose of washing his calves to detroy vermin. His wife, who was sick at the time, and had some herb tea prepared, took in mistake a tumbler full of this hellebore decoction. It produced very alarming symptoms, vomited her very freely, and the prostration and cold sweat were fearful. By the ordinary stimulating remedies that were used she recovered in forty-eight hours.

In 1840, a person of our acquaintance prepared two quarts of syrup, from what he supposed to be two pounds of American valerian, but a mistake was made, and American veratrum was used instead. A tumbler full of this syrup was taken at a dose, and as it caused vomiting the dose was repeated. The same alarming symptoms and prostration as before described followed, but in two days he was again able to be about.

In 1858, a physician took, by mistake, thirty grains of veratrin (the combined medical principles of veratrum viride). It caused copious vomiting followed by prostration and loss of pulse at the wrist. By free use of brandy and warm external applications he recovered, and was out again on the third day.

A man, rather too fond of his neighbor's rum bottle, went into a country store, and finding a bottle marked "Old Rum," poured out and quickly drank nearly a tumbler full of tincture of veratrum viride. Not wishing the storekeeper to know of it, he said nothing about it until it caused vomiting, and then being much alarmed, told what he had done. A physician was sent for, rum was freely given, and the same night the man walked home.

See also the *North Western Medical and Surgical Journal*, November, 1857, page 493.—*Amer. Journ. Indig. Mat. Medica*, vol. i. p. 14.

greater in proportion than when the amount taken at one dose is larger.

There is probably no remedy in the whole Materia Medica that produces such a death-like pallor. The effects produced upon the countenance much resemble the appearance caused by syncope from hemorrhage.

In the cases and experiments that I have reported, of its action on animals, there are several deaths from its use by hypodermic injection, and injection into the veins, but when administered by the stomach, to cats and dogs, even in very large doses, they all recovered.

As under its administration the secretions are augmented, it is rapidly carried out of the circulation, if the secreting organs are in a healthy state, free from organic disease.

There is no question, I think, that in large doses, frequently repeated, or in cases where there is organic disease of the kidneys, it may prove fatal by its powerful sedative effect upon the circulation, causing syncope and cessation of the heart's action.

The treatment in cases of poisoning is a prompt stimulating plan. Hot spirits and water, tincture of cantharides, ammonia, electro-magnetism. The surface of the body, especially the extremities, should be kept covered, and warm cloths applied. Friction is indispensable, as it keeps the blood in motion. Clear, undiluted spirits check the painful vomiting better than any other remedy.

DIVISION ELEVENTH.

CUMULATIVE ACTION.

I have not met with any evidence that veratrum viride has a cumulative action; in fact I am satisfied that this so-called cumulative action seldom exists in any medicine, even digitalis.

This action I have frequently seen with opium, occasionally with digitalis, hyoscyamus, veratrum, &c., but only in cases where there was disease of the kidneys; and wherever I have found this so-called cumulative action, I have afterwards found albumen in the urine. In albuminuria and uræmia, therefore, veratrum, like opium, is contra-indicated, except under the most careful watching. It does not, like antimony, possess the property of *toleration*.

SECTION SIXTH.

MODUS OPERANDI.

Veratrum viride acts upon the system by transmission with the blood, and that its effects do not take place until after absorption into the blood is proved by:—

1. Its peculiar action on the system when introduced elsewhere than into the stomach.

2. The greater rapidity of its action, and intensity of its power, when introduced directly into an artery or vein.

3. Its action on the various secerning organs, either when taken into the stomach, or when introduced into an artery or vein, a serous cavity, or the cellular structure. The presence of its alkaloid in the secretions formed out of the blood; when the extract of the plant was given by the mouth; when it was introduced into a serous cavity; or into the cellular structure beneath the skin. Also, the production of its physiological action when the milk, saliva, or urine of one animal to which the tincture has been for some time administered, is given to another animal.

4. Its peculiar action upon the pneumogastric nerve when it reaches that nerve only through the circulation.

5. The absence of any impression conveyed to a distant part of the system when it is applied to the surface of the skin, together with the production of its topical effects to the nerves of the part to which it is applied, in proportion to the amount and rapidity of its absorption.

6. The dilatation of the bloodvessels after its administration, visible by the microscope in the capillaries, and sensibly felt in the larger vessels by the slower passage and increased volume of the blood; and by the free diaphoresis produced.

7. By its effects upon the blood disks, altering or diminishing their size. (See Section 3d, Division 4th.)

Professor Christison asks of somewhat similar remedies, is the peculiar effect caused "by being carried with the blood to the part

on which it acts, or by producing on the inner membrane of the vessels a peculiar impression which is conveyed along the nerves?"

There may be objections raised to the 6th and 7th propositions, on the ground that if the bloodvessels are dilated and the blood disks rendered smaller, it is not explained how inflammation is relieved; and also why the red disks do not continue as before to flow through the capillaries which, in health, only carry the white globules? It will be remembered that the flow of red blood through certain vessels only occurs in inflammatory conditions. In this inflammatory state the deranged flow may be partly owing to a *vis-a-tergo,* and an obstruction of the proper channels; or to an altered condition of the endangium of the particular part; or to an altered condition of the blood itself; all of which may be produced by a deranged condition of the methæmatous nerves of the part affected.

After the administration of veratrum viride the blood is immediately acted upon, and it exerts a sedative effect on the endangium, and causes a dilatation of the vessels, so that the blocked-up current can flow in its proper channels.

That it also exerts a powerful influence upon the vaso-motor nerves is proved by many experiments, and we have seen that when injected subcutaneously into one leg of a frog the circulation in the web of that foot was immediately stopped, while the circulation continued in the other foot for some time. It is also perhaps owing to a sedative action upon the excito-sensory nerves that it affords such rapid relief by hypodermic injection in some cases of acute neuralgia; for it has been demonstrated by Marshall Hall and Claude Bernard, that these nerves are not always distinct in their distribution, but run in company with other and larger branches of nerves.

I need hardly repeat that this remedy is most successfully used in diseases in which there is an accelerated circulation, owing to inflammation or irritation. May not this diseased condition be relieved by the action of the medicine upon the endangium through the blood itself?

This internal membrane of the vessels (membrana vasorum commure endangium[1]) is common to all the vessels of the circulatory apparatus from the heart, to the smallest capillary. It is a very thin, transparent membrane, possessed of neither visible fibres,

[1] Burbach, ff. 698. Meigs, Diseases of Females, p. 342.

vessels, or nerves. It is easily torn, and its connection is severed by the application of a ligature to a vessel, but it is readily reproduced. It is, in fact, almost, if not quite, the only channel or limitation for the circulation of the blood in the small capillaries, and as circulation is established in new formations, its growth keeps pace with the passage of the blood. As I have before said, it possesses neither visible fibres, vessels, or nerves, but is in itself one vast nervous communication, receiving healthy or diseased impressions from the blood, upon which it depends for the healthy performance of its functions. Like every other organ of the body it is formed from the blood, and when once formed it has special duties to perform, which duties are in part the communication of the proper nervous influences to the blood itself. It receives impressions from the blood, and in its turn communicates an action to the blood, and performs the finishing stroke in the transformation of the living plasma.

From observations on the use of this remedy, and from numerous experiments I have performed, it seems to me more than probable that it exerts its special and peculiar influence upon this endangium, or, as it might be designated, blood-nerve membrane. That its primary influence after absorption is upon this membrane, and that all of its other effects are owing to this influence; as the dilatation of the vessels; the contraction of the blood disks; the increase of secretion; the resolution of congestion; the loss of muscular power; and paralysis of the heart's action. The cause of death is syncope—cessation of the action of the heart, a paralysis of its muscular structure, owing to the inability of the blood to communicate a continuous electro-tonic, or life force to the muscle.

Dr. A. Billing, in his *Principles of Medicine*,[1] considers that all the medicines that have been called specifics, as mercury, arsenic, and colchicum, are *not* specifics, but that they owe their curative power to the capability of subduing different kinds of inflammation, or inflammatory poisoning, by causing contraction of the dilated capillary vessels.

Mr. Wharton Jones, in his "Sir Astley Cooper Prize Essay," states that medical solutions applied to the web of the frog's foot produce very various effects upon the capillaries; and that sulphate of copper, an irritant and astringent, has caused dilatation, while atropia, which causes such marked dilatation of some tissues, has in these cases produced contraction of the capillaries.

[1] Fifth edition, pp. 70–75.

There are many who reason from these experiments of Mr. Jones, that the effects of medical agents upon the capillaries are *not*, and cannot be constant in their character. And yet in my opinion they are of no value whatever in deciding the effects of medicines upon the capillary circulation. They were applied externally only, and not internally, and their first effect would be on the *nerves*, not on the capillaries, and the effects described would be just such as might be expected when applied externally or not within the circulating fluid of the capillary itself. In the first instance an irritant, almost an escharotic, is applied to the surface, and it inflames the whole surrounding tissue, capillaries included, and as the primary effects pass off *dilatation of the vessels* affords relief to the part. In the latter case a powerful sedative is applied, and through its influence upon the peripheral nerves all the surrounding parts are for a while brought under its primary sedative influence; there is a lessened action, and less blood flows through the vessels of the part, nor am I aware that anybody has yet asserted that atropia causes dilatation of the capillaries; it is dilatation of some of the muscles, as the iris, that it is known to produce. This is one of its special actions, and we are every day improving in our knowledge of physiology, and of the action of medicines, by carefully noting these special actions of our various remedies.

In these cases of Dr. Billing on the effects of mercury, &c., his observations were also no doubt made with great accuracy, the conclusions only which he has arrived at from these observations are not I think entered into with sufficient correctness. That there should be a dilated state of the capillaries in syphilis, lepra, and rheumatism, would seem more than probable as the poisons circulating in the blood would deteriorate its quality to such and extent as to cause a diseased and enfeebled condition of the endangium also, and thus produce a dilatation of the capillaries. But Dr. Billing does not speak of this dilatation as caused by a disordered condition of the blood, nor does he account for the subsequent contraction of the capillaries through an improved condition of the circulating fluid by a lessening of the amount, or an entire removal of the poison, but solely to the therapeutic and peculiar action of the mercury, arsenic, or colchicum. It appears to me that his observations are correct, but that his reasonings are erroneous.

That peculiar poisons do so act as to cause contraction of the capillaries and even of the larger bloodvessels, we have sufficient proof in intermittent fever. In a paroxysm of this miasmatic

poisoning of the blood, the first symptoms are a chill and visible contraction of the external vessels of circulation; this lasts for some time; a fever then sets in, in which reaction takes place, and instead of a contracted condition of the vessels we have a state of dilatation, and the whole ends with an exudation from the vessels producing a copious perspiration, and then gradually the circulation returns to its normal state. Now that any medicine that would merely cause a dilatation of the capillaries in the first stage, or a contraction in the second, would cure the disease, I think improbable, unless at the same time it had a special catalytic effect.

The antiphlogistic effects of mercury, arsenic, &c., are partly accorded by Dr. Billing to their capability of subduing different kinds of inflammation, or inflammatory poisoning, by causing contraction of the dilated capillary vessels. But it is not even proved, it is as yet mere hypothesis, that there is dilatation of the capillaries in diseases that are cured by these remedies. There are also other remedies that are supposed to produce the same state of contraction, but which do not cure the diseases named. Other authors have assigned to the remedies in question a catalytic action, and in part attribute the cure of the diseases for which they are given to their antiplastic action on the blood, and the removal of the morbid materials, partly in this way.

Veratrum viride, although a catalytic, is unlike mercury or arsenic, for they counteract inflammatory, or poisonous processes, by slow catalytic action on the blood, whereas veratrum has a more rapid action, and produces other changes in the character of the blood, by its immediate action on the kidneys, skin, and mucous membrane, in fact a quick eliminative action produced by agency of the excito-sensory nerves. That the relief from inflammatory diseases by veratrum is alone owing to a mere dilatation of the vessels is not to be supposed, but it is owing also to a change in the character of the blood, and an action on the excito-secretory nerves, by which assimilation, elimination, and depuration are effected, and we thus have in this dilatation of the bloodvessels, and contraction of the blood disks, an explanation for the change in the character of the pulse.

Weber proved by many experiments that electro-galvanization of the vagus nerve lessened the number of the heart's pulsations, and prolonged the diastolic period; this, as we have seen, is the special action of veratrum viride, and by this almost uniform certainty of its action we have attested its very great utility as a

means of diagnosis in diseases of the heart and lungs. Weber also demonstrated that division of the par vagum caused great acceleration of the heart's pulsations, and from these experiments asserts that the par vagum controls the action of the heart.

The investigations of Marshall Hall, Bernard, and Brown-Séquard show that the pneumogastric nerve does not alone control the heart's contractions, but that other nerves have an equivalent power. Beyond the action of these we find many causes for preternatural cardiac pulsations, and we should frequently be deceived if we attributed irregularity of the heart solely to any one cause. We see by reference to Case 12, that the presence of lumbricoïdes interfered with the heart's action, and prevented the operation of the medicine; by reference to Case 11 we find the presence of lamellated patches in the veins, frequently produced hurried respirations, and pulsations, and eventually in a period of excitement caused death; in Case 7 we find that mental disturbance increased persistently and violently the action of the heart; in Case 8, pain alone increased the heart's rhythm; in Case 9, miasmatic poisoning produced the same result; in anæmia and chlorosis we find the same disturbance; and in fatty degeneration of the heart we have a lessened action from impaired contractile power; and yet in all these cases veratrum has been used, and while its influence continued the heart's pulsations were brought to a more normal standard, complete and steady contraction of its chambers taking place, and thus stability and volume given to the pulse. In almost all disease the heart's pulsations are disturbed, yet we could not suppose that by merely bringing the heart to a normal beat, we could cure, or even relieve all diseases; but there are periods during many diseases when there is a great functional disturbance of the heart, which may be temporarily relieved, while catalytic or other proper and necessary medicines may effect a change in the system and cure the disease. We thus afford present relief while we are working permanent cure.

We have in the few cases here narrated plainly *seen* the operation of this medicine and the effects produced. Its is first absorbed into the blood and there manifests its power, proved to us by the *manifest phenomena* we witness. As the medicine is conveyed with the blood to the heart, and every minute ramification of the venous system, it is thus universally distributed to every excito-motor, excito-sensory, and excito-secretory nerve, producing relaxation, alleviation, elimination, and depuration.

However slow the pulse, and we have seen in some instances with animals that it has been reduced to 16 pulsations in the minute, with but few respirations in the same time, there have been no symptoms of suffocation; and in those instances where veratrum has been administered to individuals to control diseased action, and the pulse has thereby been reduced to 30 beats in the minute, there has been no feeling of suffocation. This is because the blood conveys sufficient oxygen, and thus to the last sustains the vital wants of the system. When administering veratrum in disease we have frequently found the pulsations reduced to 30 beats in the minute (the patient expressing a sense of comfort and quietude), with a normal respiration of about 18, thus allowing the blood to circulate slowly through the lungs, and receive, if anything, rather more than its usual amount of oxygen; at any rate we find no impediment to free oxidation. The blood circulating thus slowly through the lungs, and being fully supplied with oxygen, conveys it in proper quantities to all the tissues, so that there is no sense of suffocation, no demand throughout the system for more oxygen, more arterialization. That this full supply of oxygen to all the tissues is one of the causes of the great relief afforded by veratrum viride, is demonstrable in almost every inflammatory case we treat with it, for where, before its administration, there was rapid circulation and respiration, and a sense of suffocation (or which is the same thing, the necessity for more air), as soon as its sedative effects are felt the circulation and respiration become normal in character, because, as a part of its effects, more oxygen was conveyed to the tissues, and, therefore, there was less demand for respiratory action. Rapidity of the circulation and respiration is oftentimes nothing more than a demand of the tissues of the body for more oxygen. A peculiar state of the blood or nervous system prevents the circulating fluid from becoming duly arterialized, the tissues of the body suffer in consequence, and make a demand upon both heart and lungs to compensate this loss by rapidity of both these functions. There are many exciting causes of disease which do not alter the appearance of the blood globules, but render them incapable of absorbing oxygen in sufficient quantity, and of thus carrying on what we may call the respiration of the tissues.

That the change spoken of,[1] produced in the calibre of the vessels by veratrum viride, and the alteration in the form and appear-

[1] See Section 3, Division 4th.

ance of the blood disks, has much to do in the arterialization of the tissues, we have abundant proof, so far as we learn by symptoms in almost every case of disease treated. We have seen by the post-mortem examinations that have been made, that the blood in the heart was nearly always fluid, and of a light color, that both sides of the heart were filled with blood, and clots were only found when death had been induced very slowly, or after the post-mortem examinations had been delayed for some time; that the large vessels of the lungs were filled with florid blood; and that the liver was almost always gorged with blood of a light color.

In death from hemorrhage, convulsions invariably occur, because the heart is unable to supply the brain with blood; but we have seen that with veratrum viride no convulsions occur before death, as in hemorrhage, and not even in the most powerful medicinal doses does it produce convulsions. That death from the action of veratrum viride is caused by its sedative effects upon the heart is proved by the absence of suffocation, convulsions, and convulsive efforts at respiration, and by the fact that the oxidation of the blood takes place till the last moment. It does not destroy life by apnœa, that is, by stopping the respiration, but by syncope, which is suspension of the heart's action. It would seem in this respect, as well as in the antidotal action we have before spoken of, to be directly contrary to strychnia in its action, for it has been demonstrated by Harley that strychnia in poisonous quantities prevents the blood from absorbing oxygen and exhaling carbonic acid.

There is one peculiarity in the action of this medicine that I have been unable to account for. When the tincture, the resinoid, or the alkaloid of veratrum viride has been given by the mouth in medical doses it has produced no purgative action on the bowels, but when either of these preparations has been injected into the subcutaneous cellular tissue, or into the muscles, it almost always induces an action on the bowels. If the rectum is filled with feces, they are first discharged, and afterwards small amounts of dark mucoid feces, frequently not over a drachm in weight, are discharged with some tenesmus, and upon post-mortem examinations the mucous membrane of the rectum is found reddened and congested. Why it should act in this way when injected subcutaneously, and not when taken by the mouth, I must leave for physiologists to decide.

Is veratrum viride narcotic? Tully and Osgood state that it is. But we see by the experiments and cases already narrated,

that it is not narcotic in its action, that it does not in any instance primarily exalt nervous force, but uniformly depresses it throughout the whole period of its operation.

It differs markedly from narcotics in producing no special action on the intellectual function of the brain, but it merely renders the patient languid, quiet, unwilling to be disturbed, and disposed to sleep. Under poisonous doses the functions of volition and sensation are impaired; but this is an effect produced by sedatives, and is due to derangement not of the cerebral, but of the excito-motor and excito-sensory nerves through the vascular system on which the veratrum seems to exercise special control. Consequently, unlike narcotics, it produces no deliriant action, and does not act so markedly on respiration as on the circulation, because the respiration is more under the control of the cranial nerves.

Patients under the influence of this remedy exhibit an intensification of the ordinary physiological law, in virtue of which the pulse falls during sleep; the veratrum frequently causing a diminution of 30 beats in a minute in a short time, merely by the patient falling asleep. I have carefully watched the pulse of patients during sleep who were taking this medicine, and have never known the pulse to increase suddenly, as is often the case with patients on the eve of delirium, under the influence of narcotics. Indeed veratrum simulates the remedial action of sleep by moderating the flow of blood, and thus neutralizes the effect of a diminished supply of oxygen incident to inflammation.

Paramount to all its other actions we see by the many experiments before us that veratrum viride is a *special arterial sedative*. We see that it regulates the number and character of the heart's pulsations, that it tones and controls the contractions, and thus makes more slow the rapid and irritable pulsations of a weak heart; and that it lessens the force and violence, and gives moderation to a heart rendered too vigorous by functional disturbance or exciting causes.

Veratrum viride is antiphlogistic because of its depurative action on the blood by means of the tenuous extremities of the nervous system—Marshall Hall's "methæmatous nerves." We have seen that it does not deteriorate or impoverish the blood like antimony and mercury; and it is more than probable that every portion of the medicine is soon carried out of the system by means of its potent eliminative action.

In nearly every instance of its administration it greatly augments the secretion from the skin, promotes increased expectoration, causes a rapid and increased flow of saliva; and although it cannot be said to increase the quantity of urine passed, it certainly largely augments its specific gravity, and thus is probably a more potent diuretic than though it merely increased the quantity of water; it exerts an eliminative action on the lymphatic and mammary glands, and indurations and enlargements disappear under its use. These various eliminative actions prove its high value as an anti-phlogistic.

In the relation of experiments upon animals we have given many instances where the pulse was reduced below 30 beats in the minute, and where nervous force seemed almost exhausted and life apparently seriously threatened; and yet in these seeming desperate conditions, strength is quickly regained and circulation brought to its normal condition by the administration of the proper antidotes—*stimulants*. I do not doubt that a fatal result *may* be produced, but such results must be very rare, since the effects are mainly instances of depression not of exhaustion.

Of its modus operandi when used as a means of diagnosis, I have spoken fully in the cases related.